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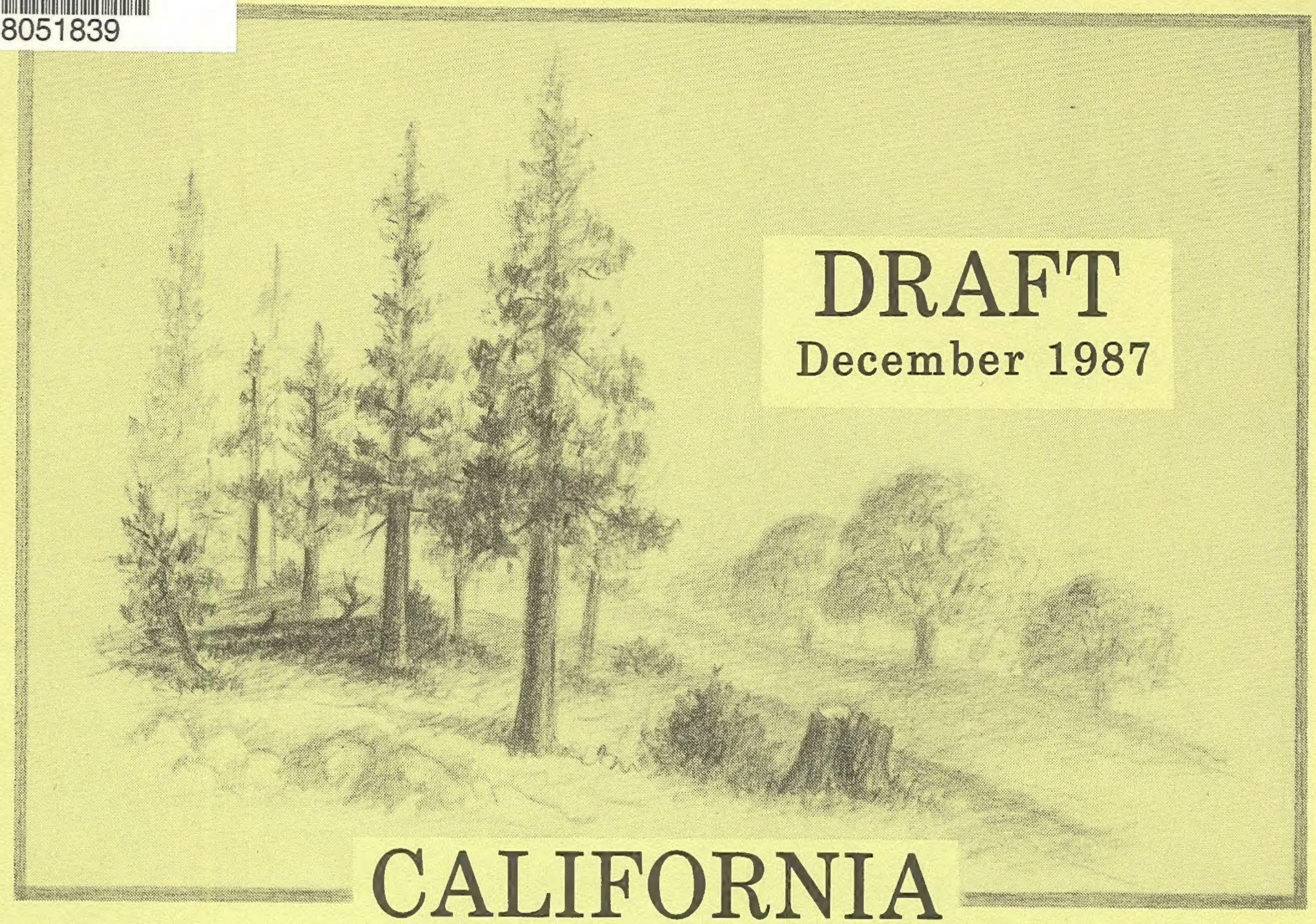

DRAFT

December 1987

CALIFORNIA VEGETATION MANAGEMENT

ENVIRONMENTAL IMPACT STATEMENT

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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
CALIFORNIA STATE OFFICE
2800 Cottage Way
Sacramento, California 95825

Dear Reader:

Enclosed for your review and comment is the Draft Environmental Impact Statement (DEIS) for the California Vegetation Management program. The DEIS analyzes impacts of controlling vegetation by means of herbicides, manual, mechanical, and prescribed burn methods on the public lands in California and northwest Nevada. Also included is a risk assessment and worst-case analysis of impacts on human health from using herbicides as proposed by the program.

Comments concerning the adequacy of this statement will be considered in preparation of the Final Environmental Impact Statement. A 60-day comment period has been established for this statement. The comment period will close on February 15, 1988.

Please send your comments on this statement to:

California State Director
Bureau of Land Management (932)
c/o Mark Blakeslee
2800 Cottage Way
Sacramento, CA 95825

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Comments received after the close of the comment period will be considered in the decision process, even though they may be too late to be specifically addressed in the final environmental impact statement.

A limited number of copies of the DEIS are available on request. Please contact the nearest BLM District Office or the above address.

Sincerely,

Ed Hastey

Ed Hastey,
State Director

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Prepared by

U.S. DEPARTMENT OF INTERIOR

BUREAU OF LAND MANAGEMENT

CALIFORNIA STATE OFFICE

Ed Hastey

State Director, California

SUMMARY

This environmental impact statement (EIS) describes and analyzes the environmental impacts of implementing a program to control vegetation on public lands in California and northwest Nevada. In accordance with the National Environmental Policy Act, this EIS identifies impacts on the natural and human environment of three alternatives. Alternative 1, the Proposed Action, is the preferred alternative.

ALTERNATIVES

The proposed program for vegetation control would involve coordination with State agencies, counties, public land lessees and adjoining landowners for both accomplishing vegetation control and ensuring adequate safety factors are applied. Chemical, manual, mechanical and prescribed fire are considered for use. For analysis purposes maximum likely rate of herbicide application is used, however the actual rate of application is expected to be lower and depends on species of vegetation, time of year, application method and formulation of herbicide. Treatment levels for the Proposed Action conform to land use plan objectives and budget capabilities on public lands. Treatment levels for Alternatives 2 and 3 are less due to feasibility and cost considerations.

ALTERNATIVE 1: PROPOSED ACTION

All methods would be available for use with a total of 35,800 acres treated annually. Herbicides would be applied aerially on 5,200 acres and ground vehicles and hand application would treat 800 and 900 acres respectively. Manual methods would treat 500 acres, mechanical treatments would treat 2,400 acres while prescribed fire would be used on 26,000 acres. All safety requirements and project design features would be followed in accordance with BLM policy and EPA registration restrictions, as they would under all alternatives.

ALTERNATIVE 2: NO AERIAL HERBICIDE APPLICATION

This alternative would eliminate the use of aerially applied herbicides and treatments by the other methods would total 31,250 acres. Ground vehicle and hand applied herbicides would be used on 800 and 1,150 acres respectively. Manual and prescribed fire methods would be unchanged from Alternative 1 at 500 and 26,000 acres while mechanical methods would increase to 2,800 acres.

ALTERNATIVE 3: NO CHANGE/NO USE OF HERBICIDES

No herbicides would be used under this alternative. A total of 30,550 acres would be treated by manual (1,200 acres), mechanical (3,350 acres), and prescribed burn methods (26,000 acres).

ENVIRONMENTAL CONSEQUENCES

AIR QUALITY

The major impact to air quality would be short-term, moderate increases in smoke intrusions from prescribed burns and dust generated by mechanical and manual methods under all alternatives. Insignificant chemical drift is expected under Alternatives 1 and 2.

SOILS

Impacts to soils would result in short-term increases in erosion with improved stability over the long term. Some persistence of herbicides would be expected in arid soils but this would not be important because the low level of herbicide expected would not affect productivity.

WATER RESOURCES

The potential for herbicides to be detected in water is greatest under Alternative 1, less under Alternative 2, and nonexistent under Alternative 3. On the other hand the potential for suspended sediment level increases in water would be greatest under Alternative 3. Through use of buffer strips and other project designs neither of these impacts would be expected to be significant.

VEGETATION

While desirable vegetation production would be greatest under Alternative 1 and least under Alternative 3, potential for injury or loss of nontarget species would also be greatest under Alternative 1 and least under Alternative 3. Noxious and poisonous weeds would be controlled under both Alternatives 1 and 2 with less than desired control under Alternative 3.

TIMBER AND SALES AND WOODLANDS

Under Alternative 1 the present annual allowable cut would be maintained, while it would decline under Alternative 2 and decline even further under Alternative 3. No impacts would be expected to woodlands other than a lessened fire hazard to hardwoods due to control of chaparral under all alternatives.

WILDLIFE

Impacts to wildlife would be either beneficial or negative depending on the type of treatment and specific location. The greater amount of beneficial impacts would occur under Alternative 1 but impacts EIS area-wide would be insignificant, and no significant toxic effects to animals are expected.

LIVESTOCK AND WILD HORSES

Production of desirable forage would be greatest under Alternative 1 and least under Alternative 3. No impacts to livestock, horses, or burros from chemicals would be expected.

CULTURAL RESOURCES

Cultural resources would be addressed by the site-specific project proposals as they are developed. The lowest potential of damage to sites would occur under Alternative 1 with an increasing potential under Alternatives 2 and 3.

VISUAL RESOURCES AND RECREATION

There would be a slight potential for negative impacts to visual resources under all alternatives. Alternatives 1 and 2 would control undesirable vegetation in recreation sites while Alternative 3 would allow less control of undesirable plant species than desired for management objectives.

WILDERNESS AND SPECIAL AREAS

There would be no impacts expected other than the slight potential for vegetation damage from accidental spraying or aerial drift of herbicides.

ECONOMIC CONDITIONS

Economics of the EIS area as a whole would be unaffected by any of the alternatives. The productivity of the public lands however would be greatest under Alternative 1 and least under Alternative 3. Local economies and individuals would be slightly affected either negatively or positively depending on their dependence on public land resources for income.

SOCIAL ENVIRONMENT

Individuals relying on public land resources for income would be most satisfied under Alternative 1 and least satisfied with Alternative 3. Those concerned with herbicide hazard would be negatively affected by Alternative 1, less negatively affected by Alternative 2 and not impacted by Alternative 3.

HUMAN HEALTH

Use of herbicides would be in compliance with EPA labels and State regulations. No adverse impacts to either the public or workers from chemicals is expected under any alternative. While workers are under the greatest risk and that risk would be highest under Alternative 2, the overall health risk is small relative to other lifetime hazards. The potential for accident from nonherbicide treatment methods would be successively higher under Alternative 2 and 3 due to increased mechanical and manual treatment efforts.

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Chapter 1

Proposed Actions and Alternatives

CHAPTER 1

DESCRIPTION OF ALTERNATIVES INCLUDING THE PROPOSED ACTION

PURPOSE OF AND NEED FOR ACTION

The Bureau of Land Management (BLM) proposes to implement a program to control vegetation on public lands in California and northwest Nevada over a 10-year period. This vegetation management would be done to control noxious and poisonous plants, maintain rights-of-way, improve forest management, range management, wildlife habitat, recreation sites and to reduce fuel load.

BLM's main authority and direction for managing public lands derives from the Federal Land Policy and Management Act of 1976, 43 USC 1700 et seq. (FLPMA). Under FLPMA, BLM must manage public lands according to the principles of multiple use and sustained yield. These principles are further qualified in FLPMA by the statutory duty that BLM prevent unnecessary degradation of the public lands. In addition, two federal laws direct weed control on federal lands: the Carson-Foley Act (PL 90-583) and the Federal Noxious Weed Act (PL 93-629).

Land use plans have been completed for the EIS area through the BLM planning process and these plans have selected the management objectives and land uses to be allowed and emphasized on the public lands. These plan decisions have chosen certain levels of use for a variety of uses ranging from wilderness designation to grazing use and timber production. To meet the sustained yield production levels called for by these management decisions it may be necessary to control vegetation in some cases. Often seeding or planting is done after vegetation control, however the purpose of this EIS will be to only evaluate the vegetation control methods. Decisions and evaluations pertaining to seeding and planting proposals are a part of BLM land use plans and EISs.

Vegetation control is necessary to maintain rights-of-way and to protect structures from fire hazards. In forest management vegetation is controlled to promote better survival for reforestation projects and faster growth of timber stands. Brush control is done to improve wildlife habitat, increase forage for livestock and to reduce fuel hazard loading for wildfires. In the desert area there is a need to reduce tamarisk invasion around desert streams and waterholes. Vegetation control is also often needed at recreation sites to maintain trails, remove poison oak and fire hazards. In urban or residential areas where public lands are intermingled with developed lots, local fire agencies require weed abatement activities be undertaken to reduce fire hazard.

Noxious weeds have become established and are spreading on public lands. Rangeland is being invaded, and wildlife habitat is being reduced causing economic loss to these resources. Noxious weeds can only be adequately controlled with joint efforts by federal, state, county and private interests.

Twenty-one noxious weeds have become established on public lands in California and northwest Nevada. The noxious weeds in California as a whole and those found on public lands in the State are listed in Appendix B. Nevada has no similar list. Accordingly, BLM proposes to implement a program for controlling or eradicating these weeds within the EIS area.

In accordance with the National Environmental Policy Act (NEPA) of 1969 (PL 91-140), this environmental impact statement (EIS) identifies impacts on the natural and human environment of the Proposed Action and other alternatives. Since BLM has already completed land use plans through the NEPA process and decided on management objectives, this EIS will not propose changes to those existing land use plans. Therefore, this EIS will only address different alternatives to accomplish the existing management objectives. Comments received in response to a March 20, 1986, Federal Register notice, local news releases and a scoping letter mailed to over 1,700 addresses generally agreed about the need for a vegetation management program EIS. When the team assembled to conduct the analysis and prepare this EIS, an internal scoping session was held to identify the team's perceptions of issues and concerns. The results of this session incorporated concerns and issues raised in the letters received. Concerns were associated with herbicide use, alternative treatment methods, insufficient control of noxious weeds, and potential effects on human health and the environment. (See Appendix A for results of scoping.) The greatest amount of concern is centered on the potential hazard of herbicides on the environment and human health.

Recently several other EISs have been completed which also address many of the issues being covered herein. These EISs have been utilized for reference in this EIS. Included are: Chaparral Management Program EIR, California Department of Forestry 1981; Vegetation Management for Reforestation Draft EIS, USFS Region 5 1983 and 1986; Northwest Area Noxious Weed Control Program EIS, BLM 1985a; Supplement to the Northwest Area Noxious Weed Control Program FEIS, BLM 1987a; Western Oregon Program-Management of Competing Vegetation Draft EIS, BLM 1983 and 1986; and Final EIS on the Eradication of Cannabis on Federal Lands in the Continental United States, DEA 1985.

ALTERNATIVES INCLUDING THE PROPOSED ACTION

Three alternatives, including the Proposed Action (Alternative 1, the preferred alternative), have been identified for impact analysis in Chapter 3. Differences between alternatives include types of treatments, treatment levels, and benefits to other resources. These relationships are shown in Table 1-1. Descriptions of the alternatives and estimates of treatment acres were developed under the assumption that each alternative could be implemented. Treatments and standard mitigation that apply to each alternative are discussed in Management Treatments and Design Features section of Chapter 1.

The California Department of Food and Agriculture has developed a list of designated noxious weed species in California (see Appendix B). The Federal Government also publishes a list of noxious weeds in 7 CFR 360 (included as part of California list). These lists are periodically updated. The programs discussed in this EIS apply primarily to weeds identified as Category A and B species on the State list, but could include any of the weeds on either list. BLM is responsible for implementing a weed control program on the land it administers.

Table 1-1

Estimated Annual Acreage of Vegetation Treatments by Alternative

Treatment	Estimated Annual Acreage (P.A.) Alt. 1	 (No Air) Alt. 2	 (No Change) Alt. 3
Chemical			
helicopter aerial	5,200	0	0
ground vehicular	800	800	0
ground hand	900	1,150	0
Manual	500	500	1,200
Mechanical	2,400	2,800	3,350
Burning	26,000	26,000	26,000
Totals	35,800	31,250	30,550

Treatments for other land uses such as forestry projects, range improvements, wildlife habitat, tamarisk removal and chaparral management or fuel load reduction would all be done under the limitations and objectives of BLM land use plans. Control of vegetation on rights-of-way, leases, and at recreation sites is primarily guided by considerations for fire safety standards, visibility needs and public safety considerations.

ALTERNATIVE 1: THE PROPOSED ACTION (PA)

Under this integrated approach, managers would use herbicide, manual, mechanical and prescribed fire methods to treat an estimated 35,800 acres annually in the EIS area (Table 1-1).

An estimated 6,900 acres would be treated with herbicides using helicopter, fixed-wing, ground vehicle and hand methods of application. Manual treatment would total approximately 500 acres, and include hand pulling and grubbing with hand tools and use of power tools such as chainsaws. Approximately 2,400 acres would be treated mechanically, utilizing mowing, dozing, tilling, chaining, and crushing. Prescribed burns would include about 26,000 acres.

ALTERNATIVE 2: NO AERIAL HERBICIDE APPLICATION

This alternative would allow the same vegetation management techniques as would the Proposed Action except that herbicides would be applied only by ground application methods. Increased use of ground application of herbicides and mechanical treatments would occur under this alternative. The average annual program would treat approximately 31,250 acres, with 1,950 acres treated with vehicular and backpack applied herbicides, 500 acres manually, 2,800 acres mechanically, and 26,000 acres with prescribed burns. While the amount of ground herbicide use and mechanical treatments would be increased over Alternative 1, the increase would not make up for most of the aerially treated acres dropped between Alternative 1 and this alternative. These other methods do not totally make up for the dropped aerial spraying due to feasibility reasons (e.g., slope) and costs.

ALTERNATIVE 3: NO CHANGE/NO USE OF HERBICIDES

Under this alternative, the present situation would continue and herbicides would not be used under any circumstances. The use of manual and mechanical measures would be increased in an attempt to meet vegetation control objectives, but would fall short of the objectives. Total acres treated would be 30,550 with approximately 1,200 acres treated manually, 3,350 acres mechanically, and 26,000 acres with prescribed burns.

ALTERNATIVES CONSIDERED BUT DROPPED FROM DETAILED ANALYSIS

Two other alternatives were considered initially but were dropped from analysis. Biological control of vegetation was suggested by several scoping letters. However, upon examination no proven biological methods exist to address the types of vegetation control needed by BLM. Insects, pathogens, nematodes and viral agents affect very specific plant species. Use of goats or other animals to forage on target species is impractical because it is not possible to limit grazing to target species, the types of vegetation needed to be controlled cannot be utilized by animals (e.g., manzanita) and the cost of handling and controlling the animals is prohibitive.

A No Prescribed Burning Alternative was also considered but dropped for several reasons. The primary benefit of prescribed burning is fuel load reduction and there seems to be no other viable method to remove fire fuel loads without burning it. Most burn areas are steep and inaccessible so mechanical means are inappropriate, animals cannot utilize the woody vegetation, and herbicide use would simply provide greater amounts of dead vegetation which would burn even hotter in a wildfire situation. Manual removal of chaparral is impractical due to very poor accessibility and the high costs which would be incurred. In addition Memoranda of Understanding with the State and other agencies and landowners would be violated if BLM was to eliminate prescribed burns on public lands.

VEGETATION MANAGEMENT TREATMENTS AND DESIGN FEATURES

The purpose of this section is to discuss preventive measures, treatment methods, and protective measures (design features) that would be used in a vegetation management program. Table 1-1 shows the treatments that would be applied under each alternative. Some acres may receive one or more treatments in combination, including such treatment combinations as herbicide application and burning, mechanical treatment and burning, and manual treatment and herbicide application. Treatment would occasionally have to be repeated in some situations, but on most treated areas a single treatment would suffice for several years. These interrelated treatments are explained more fully in Appendix C which describes what the different objectives for treatments are and how they are done.

Pretreatment surveys would be conducted in accordance with BLM Manual 9222 before a decision is made to use herbicides on a specific tract (Appendix D). Such surveys would involve consideration of all feasible treatments, including potential impacts, effectiveness, and cost (see Appendix E). Information from such surveys would be used as a basis for prescribing treatments.

Special provisions for treatments would be selected according to the scope of the action, accepted mitigation measures, and the physical characteristics of the specific site. BLM manuals, manual supplements, and field guides provide a variety of approved standard and special provisions. These provisions are updated periodically as pre- and post- treatment analysis finds a need for change.

Prior to any vegetation treatment or ground disturbance, BLM policy requires a survey of the project site for plants and animals which are federally listed as threatened or endangered, species proposed for such listing, and sensitive species (see Glossary). If a proposed project may affect any listed or proposed Federal threatened or endangered species or its Critical Habitat, BLM will make every effort to modify, relocate, or abandon the project to eliminate all effects. If BLM determines that such a project cannot be altered or abandoned, formal Endangered Species Act section 7 consultation (or conference for proposed species) will be initiated with the U.S. Fish and Wildlife Service (50 CFR 402; Endangered Species Act of 1973, as amended). State listed species are similarly protected and BLM will notify the State as outlined in BLM California Manual Supplement 6840.2.

In addition to protection afforded federally listed species by the Endangered Species Act of 1973, as amended, BLM policy as elaborated in Instruction Memorandum No. CA-85-35, conveys a similar level of protection to sensitive plant species.

Vegetation control activities in wilderness study areas (WSAs) would only be undertaken when no other effective alternative exists. BLM is required to manage WSAs so as not to impair their suitability for preservation as wilderness. Therefore, some actions can occur in WSAs that would not be allowed in wilderness areas. These actions, however, could not impair wilderness values at the time the Secretary of the Interior submits his wilderness suitability recommendations to the President (BLM Interim

Management Policy and Guidelines for Lands Under Wilderness Review, USDI, BLM 1979). For the most part vegetation treatments can be undertaken only to maintain previous treatments which were apparent at the time the Wilderness Review process started. Prescribed burns can be done only to maintain fire dependent vegetation and control of small areas of noxious weed or poisonous plant infestations may be undertaken when there is no effective alternative.

In wilderness areas, BLM's policy is to allow natural ecological processes to occur and to be interfered with only in rare circumstances. Noxious weeds would not ordinarily be controlled in wilderness areas unless these weeds threaten outside lands or are spreading within the wilderness. In those cases, noxious weeds may be grubbed or controlled with chemicals, provided the control can be effected without seriously impairing wilderness values (BLM Wilderness Management Policy--USDI, BLM 1981b). Other vegetation control in designated wilderness areas would only be undertaken as necessary to maintain wilderness character or as allowed under the specific wilderness plan.

Whenever evidence of historic or prehistoric occupation is found during BLM activities, special surveys are undertaken to determine possible conflicts in management objectives. In addition, a Class III (complete) cultural resources inventory is required on all areas to be subjected to ground disturbance. This inventory is conducted in the preplanning stage of an action, and the results are analyzed in an environmental analysis addressing the action (BLM Manual 8100, Cultural Resource Management). When a cultural resource that might be harmed is discovered during weed treatment, nearby operations are immediately suspended and may resume only upon receipt of written instructions from the BLM authorized officer. Procedures under the California Statewide Programmatic Memorandum of Agreement and/or, 36 CFR 800 would be followed, including consultation with the State Historic Preservation Officer in determining eligibility for nomination to the National Register of Historic Places, effect, and adverse effects.

CHEMICAL METHODS

The specific plant, stage of plant growth, and season of application are especially important in prescribing chemical (herbicide) treatments as proposed by Alternatives 1 and 2. Plant susceptibility to herbicides varies seasonally and widely throughout the EIS area. Information on the most effective timing of applications appears in published research and on herbicide labels.

While this EIS will cover specifically the use of 16 herbicides, others have been proposed or may be proposed in the future, for use by private parties on their mining claims, leases or rights-of-way. Chemicals other than the 16 covered herein will not be allowed for use on public lands until risk assessments can be prepared for those chemicals. The use of paraquat for cannabis eradication has been addressed by such a risk assessment by DEA 1985 and, in accordance with 40 CFR 1502.21, that EIS is adopted by reference.

Since specific herbicides affect plant species differently, it is difficult to state in other than general terms what plants they affect. To determine the specific species affected herbicide labels should be used. For use to control broad leaf plant species without affecting grasses the following herbicides are generally used: 2,4-D, 2,4-DP, dicamba, picloram, and triclopyr. Dalapon is used for control of grasses. Broad spectrum and nonselective herbicides include amitrole, atrazine, bromacil, diuron, glyphosate, hexazinone, and tebuthiuron. Simazine is used on aquatic species. Fosamine is used to control woody vegetation, while ferns are controlled with asulam.

Information on herbicides proposed for use is presented in Table 1-2. More detailed information can be found in Appendix F, on herbicide labels, or in the following documents: Pesticides Background Statement (USDA, FS 1984), Supplement to the Western Oregon Program - Management of Competing Vegetation (USDI, BLM 1986), Herbicide Handbook of the Weed Society of America, 5th Edition, 1983, and Agricultural Chemicals Book II Herbicides (Thomson 1983). Herbicides would be applied and monitored in accordance with BLM Manual 9222, Chemical Pest Control, and in accordance with the herbicide label.

Herbicide formulations have been evaluated in order that use of products with inert ingredients of toxicological concern is avoided if possible. EPA lists inert chemicals by level of toxicological concern. EPA's Lists 1 and 2 are those which are known to be hazardous, or suspected of being hazardous. Lists 3 and 4 contain chemicals which have no evidence of toxicity concern or are recognized as safe. Those products discussed in Table 1-2, and more specifically in H-6, were screened to ensure that only brands with inerts which are not on either of EPA's lists of concern (Lists 1 and 2) are proposed for use. For a couple of herbicides, brands which contain a petroleum distillate of concern have been listed and are further addressed within Appendix H.

Herbicides are applied in several ways, depending upon the treatment objective, topography of the treatment area, target species, expected costs, equipment limitations, and potential environmental impacts.

Herbicide applications would be timed to have the least impact on nontarget plants and animals consistent with the objective of the vegetation control program. Table 1-3 shows the types of treatment and estimated acreage proposed by plant communities within the EIS area.

Rates of herbicide application would depend on the target species, other vegetation present, soil type, depth of the ground water table, and presence of other water sources. Where weeds have infested riparian areas and woody draws, the rate of application would be reduced to reduce injury to nontarget species.

Aerial applications could be done by either helicopters or fixed-wing aircraft, and nozzles to reduce drift would be used for all liquid applications. Liquid herbicides would not be applied when wind speeds exceed 5 miles per hour (mph), and granular herbicides would not be applied when wind speeds exceed 10 mph. Herbicides would not be applied when conditions

Table 1-2

Estimated Annual Acreage of Chemical Treatment by Method and Herbicide[1]

Herbicide	Major[2] Trade Name	Expected[3] Rate of Application	Estimated Annual Acreage	
			Proposed Action Alt. 1	No Aerial Alt. 2
Helicopter or Fixed-Wing				
2,4-D amine salt or butyl ester	Esteron, DMA	2.5 lbs. ai/acre	3,500	0
Picloram	Tordon	1 lb. ai/acre	700	0
Triclopyr	Garlon	2 lbs. ai/acre	600	0
Hexazinone	Velpar, Pronone	2.5 lbs. ai/acre	280	0
Atrazine	Aatrex, Drexel Atrazine	3.75 lbs. ai/acre	120	0
Ground Vehicle				
Glyphosate	Rodeo	2 lbs. ai/acre	100	100
2,4-D amine salt or butyl ester		2.5 lbs. ai/acre	100	100
Picloram	Tordon	1 lb. ai/acre	100	100
Hexazinone	Velpar, Pronone	2.5 lbs. ai/acre	50	50
Triclopyr	Garlon	2 lbs. ai/acre	50	50
Tebuthiuron	Spike	2.2 lbs. ai/acre	100	100
Diuron	Drexel Diuron	4 lbs. ai/acre	50	50
Amitrole[4]	Amino Triazole	2 lbs. ai/acre	50	50
Dicamba	Banvel	1 lbs. ai/acre	100	100
Dalapon	Dowpon	4 lbs. ai/acre	100	100
Ground Hand				
Picloram	Tordon	1 lb. ai/acre	240	290
Glyphosate	Rodeo	1.5 lbs. ai/acre	150	150
Triclopyr	Garlon	2 lbs. ai/acre	150	200
Dalapon	Dowpon	4 lbs. ai/acre	50	50
Dicamba	Banvel	1 lbs. ai/acre	50	50
Hexazinone	Velpar, Pronone	1.12 lbs. ai/acre	50	50
2,4-D	Esteron, DMA	2 lbs. ai/acre	50	200
Atrazine	Aatrex, Drexel Atrazine	3 lbs. ai/acre	10	10
Tebuthiuron	Spike	1.5 lbs. ai/acre	50	50
Asulam	Asulox	1.2 lbs. ai/acre	20	20
Bromacil	Hyvar X	4 lbs. ai/acre	20	20
Simazine	Pricep	2 lbs. ai/acre	20	20
Fosamine	Krenite	3 lbs. ai/acre	20	20
2,4-DP	Weedone 2,4-DP	2 lbs. ai/acre	20	20

[1] Liquids would be applied using water as the carrier.

[2] See specific formulations proposed for use in Table H-6.

[3] Expected application rates that would be used, actual application rates may be less. ai = active ingredient.

[4] Amitrole has recently been listed as a carcinogen on the list of chemicals developed under the California Safe Drinking Water and Toxics Enforcement Act of 1986. Use of Amitrole may be subject to special procedures or restrictions due to this Act.

Table 1-3

Proposed Treatments by Plant Community

Affected Plant Community	Treatment Method	Annual Acreage			Purpose
		Alt. 1	Alt. 2	Alt. 3	
Chaparral	Aerial Spraying	1700	0	0	Prescribed Burn Pretreatment
Sagebrush	Aerial Spraying	2900	0	0	Range Improvement
Yellow Pine Forest	Aerial Spraying	200	0	0	Forest Management
Mixed Evergreen Forest	Aerial Spraying	400	0	0	Forest Management
Sagebrush	Ground Vehicle	50	50	0	Noxious Weeds, ROWs
Valley Grassland & Woodland	Ground Vehicle	630	630	0	Noxious Weeds, ROWs
Desert Scrub	Ground Vehicle	20	20	0	Noxious Weeds, ROWs
Yellow Pine Forest	Ground Vehicle	50	50	0	Forest Management
Mixed Evergreen Forest	Ground Vehicle	50	50	0	Forest Management
Sagebrush	Ground Hand	50	50	0	Noxious Weeds, ROWs
Valley Grassland & Woodland	Ground Hand	500	500	0	Noxious Weeds, ROWs
Yellow Pine Forest	Ground Hand	50	100	0	Forest Management
Mixed Evergreen Forest	Ground Hand	150	350	0	Forest Management
Desert Riparian	Ground Hand	150	150	0	Tamarisk Removal
Yellow Pine Forest	Manual	195	195	250	Forest Management
Juniper Woodland	Manual	200	200	200	Range Improvement
Desert Riparian	Manual	25	25	50	Tamarisk Removal
Valley Grassland & Woodland	Manual	30	30	400	ROWs, Oil and Gas Fields
Mixed Evergreen Forest	Manual	50	50	300	Forest Management
Chaparral	Mechanical	1,425	1,425	1,650	Chaining, Crushing
Valley Grassland & Woodland	Mechanical	400	400	600	ROWs, Oil and Gas Fields
Alkali Sink	Mechanical	100	100	100	ROWs, Oil and Gas Fields
Yellow Pine Forest	Mechanical	400	500	500	Forest Management
Mixed Evergreen Forest	Mechanical	75	75	100	Forest Management
Sagebrush	Mechanical	0	300	400	Range Improvement
Chaparral	Prescribed Burn	14,900	14,900	14,900	Fuel Reduction, Wildlife Habitat Improvement
Sagebrush	Prescribed Burn	11,000	11,000	11,000	Range Improvement
Mixed Evergreen Forest	Prescribed Burn	100	100	100	Forest Management
Total		35,800	31,250	30,550	

stated on the herbicide label cannot be met and when air turbulence significantly affects the desired spray pattern. Buffer zones (see Glossary) to protect water resources would be provided according to individual California and Nevada State regulations and guidelines.

Vehicle-mounted sprayer (handgun or boom) applications would be mainly used in open areas that are readily accessible by vehicle. The boom would be used only where feasible to treat concentrated weed infestations and to clear undesirable vegetation, as in tree plantations and conifer release. The handgun would be used for spot treatment of weeds and no closer than the high-water line near water bodies. Neither handguns nor booms would be used in riparian areas where weeds are closely intermingled with shrubs and trees. Under both handgun and boom methods, sprays would be applied at a height of 1.5 to 2 feet when wind velocity is below 8 mph, except in riparian areas where treatment would be applied only at wind velocities below 5 mph. Boom sprayers would not be used within 25 feet of water bodies.

Hand applications could involve backpack spraying, wiper application, and cyclone broadcast spreading (granular formulations). Backpack sprayers are operated at low pressure and low volume and release herbicide through a single nozzle held from 0.5 to 2.5 feet above the ground when wind velocities do not exceed 8 mph. (Near water, wind velocities cannot exceed 4 mph.) Contact systemic herbicides (see Glossary), wiped on individual plants, would be used no closer to water than the existing high-water line. Granular formulations would be applied through broadcast spreaders at about 3.5 feet above the ground and no closer than 10 feet from the high-water line of streams and other water bodies.

Another hand application technique used for control of undesirable trees and brush, especially tamarisk in the desert, involves the complete or partial cutting of the trunk and application of herbicide to the cut portion of the plant. This method is called the cut and squirt and proves to be a very selective herbicide application technique.

MANUAL METHODS

Hand pulling and hand tools (shovel, hoe, pulaski, chainsaws) would be employed under all alternatives (Table 1-1). These methods are highly labor intensive, requiring periodic retreatment, ranging from every three weeks during the growing season to annually, depending on the target species. These methods have been successful in controlling annuals and biennials but have shown only limited success in effectively controlling creeping perennials and brush species.

MECHANICAL METHODS

Chaining, crushing, dozing, mowing, and tilling would be used under all alternatives (Table 1-1).

Mechanical methods range from prevention of seed production to total destruction or removal of plants. This method may also weaken nontarget species in treated areas.

PRESCRIBED BURNING

Prescribed burning would be conducted when weather or fuel conditions are favorable and as approved by local air pollution control districts responsible for smoke management. Burning permits will be obtained where required. BLM prescribed burns are often coordinated burns with the California Department of Forestry and Fire Protection or other agencies and landowners.

All burning would be conducted in accordance with BLM's Fire Management Policy (BLM Manual 9210), which requires the preparation of a prescribed burning plan before every burn. The prescribed burning plan addresses the following: physical characteristics of the burn area, objectives of the burn, fuels on site (loading and characteristics), weather conditions under which the plan will be carried out, expected fire behavior, air and water quality restrictions, ignition pattern and sequence, emergency fire control force requirements, public contacts, and safety.

Two methods are normally used in igniting prescribed burns. Either ground application, including terratorch, drip torches and fuses, or aerial applications which include helitorch or aerial ignition device systems are used to ignite fires. The terratorch is the use of truck-mounted propane flamethrowers. Drip torches are used to apply a burning mixture of diesel fuel and gasoline by hand. Hand-held fusees are similar to flares and are touched directly to the vegetation to ignite it. The primary method used in California is the helitorch which is an apparatus carried by a helicopter which drops an ignited gel onto the vegetation. Aerial ignition device systems include grenade-type igniters and other aerial launched methods. Whatever method may be used, the burn area is traversed in a specified pattern described in the prescribed burning plan. Tailoring traverse patterns to each burn area can maintain effectiveness, maximum safety, and control.

COMPARISON OF IMPACTS

Table 1-4 compares the impacts of all three alternatives. Although the impacts are described in detail in Chapter 3, Table 1-4 is presented to assist decisionmakers and reviewers by concisely summarizing and comparing the major impacts by alternative.

IMPLEMENTATION

FINAL DECISIONS

Thirty days after the final EIS is published, BLM decisionmakers will evaluate public comment on the draft and final EISs and prepare a record of decision. The decision may be to select one of the alternatives intact or to combine features from several alternatives that fall within the range of actions analyzed in this EIS. The Record of Decision will address significant impacts, alternatives, environmental preferences, and relevant economic and technical considerations.

Table 1-4. Summary of Impacts by Alternative

Resource Value	Existing Situation	Alternative 1 Proposed Action	Alternative 2 No Aerial Herbicides	Alternative 3 No Change/No Herbicides
Air Quality	Air quality in area generally good overall with problems primarily restricted to urban areas.	Moderate, short-term increases in smoke intrusions expected, but standards not expected to be exceeded. Localized fugitive dust expected from manual and mechanical treatments. Some insignificant chemical drift and volatilization from herbicides.	Similar to Alternative 1, except less chemical drift and volatilization, and slightly more dust.	Same as Alternative 1, except no impacts from herbicides and more dust from increased mechanical treatments.
Soils	Great variation of soils in EIS area due to differences in climate, parent material, topography, and vegetation.	Short-term increases in erosion, long-term stabilization. Possible herbicide persistence in arid soils.	Slightly more erosion and less chance of herbicide persistence.	Greater short-term increases in erosion. No herbicide impacts.
Water Resources	Water quality varies throughout the EIS area.	Little chance of detectable levels of herbicides entering streams from drift and spraying in ephemeral channels. Short-term increases in sediment from mechanical and prescribed burn treatments offset by reduction in wildfire impacts.	Less spray drift and no spraying in ephemeral channels, slightly more sediments from more mechanical treatments.	No impacts to water from chemicals. Localized increases in suspended sediments and dissolved solids from mechanical treatments.
Vegetation	Presently desirable vegetation is competing with undesirable plants and/or noxious plants.	Present commercial conifer production would be maintained. Production of grass species would increase. Noxious weeds would be reduced or eliminated. Some injury or loss of nontarget vegetation would occur.	Commercial conifer production would decline but to a lesser extent than Alternative 3. Production of grass species would increase but to a lesser extent than under Alternative 1. Noxious weeds would be reduced or eliminated. Less injury or loss of nontarget species would occur than under Alternative 1.	Desirable vegetation production would decline. Noxious weeds would be controlled but not to degree desired. Least impact to nontarget plant species.

Table 1-4. Summary of Impacts by Alternative (Cont.)

Resource Value	Existing Situation	Alternative 1 Proposed Action	Alternative 2 No Aerial Herbicides	Alternative 3 No Change/No Herbicides
Timber Sales	Present annual allowable cut of 21.6 million board feet.	Annual Allowable cut maintained at 21.6 million board feet.	Annual allowable cut would decline to 20.5 million board feet.	Annual allowable cut would decrease to 17.3 million board feet.
Woodland Products	Presently there are 539,000 acres of woodlands with juniper woodland yield exceeding demand for products while hardwood demand is greater than the sustained yield.	Little to no impact to juniper woodlands and impacts to hardwoods only from accidental drift or burning. Prescribed burning of chaparral would benefit hardwoods by lessening fire hazard.	Same as Alternative 1 except greatly lessened chance of chemical drift affecting hardwoods.	Same as Alternative 2 with no chance of herbicide effects.
Wildlife	Many different animals with a very diverse variety of habitats on public lands.	Localized beneficial and negative impacts to wildlife habitat and species. Impacts EIS areawide would be insignificant. No significant toxic effects on wildlife from chemicals.	Same as Alternative 1, but fewer beneficial impacts due to inability to pretreat with herbicides for prescribed burning and fewer possible chemical impacts to species.	Same as Alternative 2, but slightly fewer beneficial impacts such as tamarisk eradication.
Livestock and Wild Horses	Forage production is lower than desired due to competition of undesirable plants or noxious weeds.	Desirable forage species for livestock and wild horses would increase. Some shrubs and trees used for shelter would be killed. Negligible impacts would occur from exposure to herbicides.	Impacts similar to Alternative 1, except that the magnitude of forage increase would be less, and no impact to shelter vegetation.	Desirable forage species would decrease due to increased competition from undesirable plants and noxious weeds, where manual and mechanical measures are ineffective.
Cultural Resources		Low possibility of site damage.	Slightly higher possibility of damage than Alternative 1.	Highest possibility of damage.
Visual Resources and Recreation	Wide variety of visual and recreational experiences on public lands.	Slightly negative impacts to visual resources with effective control of undesirable vegetation in recreation sites.	Same as Alternative 1.	Same as Alternative 1, except less control of undesirable vegetation in recreation sites.

Table 1-4. Summary of Impacts by Alternative (Cont.)

Resource Value	Existing Situation	Alternative 1 Proposed Action	Alternative 2 No Aerial Herbicides	Alternative 3 No Change/No Herbicides
Wilderness and Special Areas	Five designated BLM Wilderness Areas and 6.9 million acres of Wilderness Study Areas.	Possible impacts from accidental aerial spraying or drift.	No impacts.	Possible less than adequate control of noxious weeds.
Economic Conditions	Local economies rely on production of public lands and expenditures for vegetation control also support local economies.	Beneficial impacts of continued productivity and control of noxious weeds to eliminate competition with income producing plants. Expenditures for control of vegetation also result in gains to local economies.	Same as Alternative 1, with slightly lowered productivity and less money spent on program and thus lessened local economy.	Lessened public land productivity and more competition between noxious weeds and income producing plants. Lowered long-term economic productivity of public lands.
Social Environment		Beneficial effects due to local economic conditions, with some perceived hazard to social well being due to herbicide use.	Same as Alternative 1, except lessened beneficial gains and lessened perceived herbicide danger.	Negative impact to local economic conditions. No perceived danger from herbicides.
Human Health		No adverse impacts expected from use of herbicides or other control methods.	More workers exposed to herbicides and mechanical equipment accidents.	More workers exposed to accidents from manual and mechanical control activities.

MONITORING AND STUDIES

Vegetation management treatment contracts are continuously monitored while the work is being done. Prescribed burns are monitored in progress, and the effectiveness of burns is assessed in postburn evaluation reports. Vegetation management at most recreation sites and along roads and hiking trails is routine maintenance work conducted and monitored by Bureau employees.

Impacts of vegetation treatments on other resources would also be monitored. Currently, the California Air Resources Board monitors air quality by measuring particulate levels in the atmosphere. Water quality monitoring would be carried out in accordance with Executive Orders 11514 (partially amended by 11991) and 12088, Sections 208 and 313 of the Clean Water Act, BLM Manual 7240, and basin-specific water quality plans. Additional monitoring systems for other resources (watershed, wildlife, vegetation, etc.), as identified and outlined in the final decision and site-specific EAs, will be developed and implemented (Appendix D). Effectiveness of mitigating measures identified in project-specific environmental documents will be monitored through periodic inspections of selected projects.

REQUIREMENTS FOR FURTHER ENVIRONMENTAL ANALYSIS

This EIS is a programmatic statement for vegetation management on BLM-administered lands in California and northwest Nevada and is intended to guide this program for the next 10 years. Site-specific environmental analysis and documentation (including application of categorical exclusions where appropriate) will be prepared at the district or resource area level on the proposed site-specific vegetation control plans. During site-specific analysis and documentation, public involvement will occur in accordance with the CEQ Regulations for implementing NEPA. Interdisciplinary impact analyses will be based upon this and other EISs, such as resource management plan, timber management plan, and grazing management plan EISs.

If analysis finds potential for significant impacts not already described in an existing EIS, another EIS or a supplement to an existing EIS may be required.

INTERRELATIONSHIPS

The scattered nature of BLM-administered land in the EIS area makes it essential for BLM to coordinate its management activities with adjacent landowners and managers. BLM also works closely with other government agencies responsible for special resource management programs. This section briefly describes major interrelationships involved in the vegetation control program.

Federal Government

BLM shares common boundaries with several national forests and routinely coordinates with Forest Service supervisors and staffs. Specific project and program coordination takes place as needed between all management levels of each agency. The Forest Service Region 5 is a cooperator with BLM on this EIS in order that they can later document the chemical hazard portion of this EIS, but the impact analysis does not assess any proposed treatments of the Forest Service.

The U.S. Environmental Protection Agency (EPA) has responsibility for herbicide registration (40 CFR 162), including determining that a herbicide will not generally cause unreasonable adverse effects on the environment. EPA's determinations are based upon research data supplied by the applicant for registration.

The U.S. Fish and Wildlife Service administers the Endangered Species Act of 1973 (PL 93-205), as amended. Accordingly, BLM consults with that agency when it is determined that a federally listed or proposed threatened or endangered species or its critical habitat may be affected. The purpose of consultation is to avoid adverse impacts to the species in question. Such consultation may result in modification or abandonment of an action.

The National Park Service (NPS) administers the Nationwide Rivers Inventory, as provided under the National Wild and Scenic Rivers Act of 1968 (PL 90-542). Present efforts are directed toward inventory and evaluation to determine which free-flowing rivers and river segments are suitable for possible designation as components of the National Wild and Scenic Rivers System. BLM consultation with NPS is required if proposed management actions could alter a river's ability to meet established Wild and Scenic Rivers Act eligibility, classification criteria, or both. BLM also shares common boundaries with several national parks and monuments and routinely coordinates with Park Service management.

Tribal governments will be consulted when vegetation is controlled along the common boundaries between BLM and Indian trust lands. Consultation with potentially concerned Native American tribal groups and organizations will be undertaken as an aspect of the site-specific EAs (to be done after this programmatic EIS) consistent with BLM Manual Supplement 8100 Rel. 8-1 and the MOU among BLM, NAHC, and the California SHPO.

State and Local Governments

Section 202(c)(9) of the Federal Land Policy and Management Act requires BLM to develop resource management programs consistent with those of State and local governments to the extent that such BLM programs are also consistent with Federal law and regulations. BLM coordination efforts involve a number of State and local agencies as described below.

Section 202(c)(8) of the Federal Land Policy and Management Act requires BLM to provide for compliance with applicable pollution control laws, including State and Federal air and water pollution standards or implementation plans.

Permittees and grantees operating within rights-of-way on BLM-administered lands are required to comply with Department of the Interior herbicide regulations.

California

The Office of Planning and Research for the State of California is the clearinghouse for State agencies to which BLM provides notices of all its major proposed actions for coordinated State-level review. BLM has notified the clearinghouse of plans to prepare this EIS and will provide copies of the EIS for the State review as provided for by the MOU between BLM and the clearinghouse.

BLM has established relations with the California State Department of Food and Agriculture to ensure cooperation and coordination in noxious weed control and eradication efforts. BLM districts coordinate on a project-specific basis with the individual county agricultural commissioners. The Department of Food and Agriculture also has regulatory responsibility over herbicide use within the State.

The California Department of Fish and Game (CDF&G) has the responsibility for managing California's wildlife and fish. In managing lands under its jurisdiction, BLM considers wildlife habitat as a resource category. The Sikes Act (PL 93-452), as amended, is the main tool guiding coordination between BLM and CDF&G. Cooperative agreements and memorandums of understanding describe the responsibilities of the two agencies. Actions possibly affecting State listed threatened and endangered species are also coordinated through CDF&G.

To comply with the Clean Air Act of 1963 (PL 88-206), as amended, BLM cooperates with the local Air Pollution Control Districts (APCD). The main objective is to keep smoke from prescribed fires away from population centers and other smoke-sensitive areas. Burning is allowed only when smoke dispersion conditions are determined to be favorable by the APCDs.

The California State Water Resources Control Board through the Regional Water Quality Control Boards has lead responsibility for statewide water quality management planning in accordance with Section 208 of the Federal Water Pollution Control Act (PL 92-500), as amended by the Clean Water Act (PL 95-217) and the BLM management practices are designed to meet or exceed objectives of the statewide water quality management plan.

The California Department of Forestry and Fire Protection (CDF) has responsibility for administering the State's Chaparral Management Program and other prescribed burn programs throughout the State on non-Federal lands. BLM and CDF are signatories, along with several other state and Federal agencies, of a MOU on Coordinated Resource Management Planning, a program under which many interagency prescribed burns are presently conducted.

Nevada

The Nevada State Clearinghouse was notified of the development of the EIS and will be provided copies of the EIS for coordination of State agency review. BLM also will coordinate with the Nevada agencies affected by BLM's on-the-ground actions. These agencies would include the Department of Wildlife and the State and County Agricultural Commissions.

Private Landowners

Because private landowners are highly interested in BLM operations near their land, BLM strives to keep these landowners informed about its operations. Before preparing environmental documents at the state, district, or resource area level, BLM invites interested landowners to comment on proposed programs. Before aerial application of herbicides, BLM informs local newspapers and all residents and contiguous landowners within a half-mile of spray sites.

CHAPTER 2

AFFECTED ENVIRONMENT

CHAPTER 2

AFFECTED ENVIRONMENT

CLIMATE AND AIR QUALITY

The climate of the EIS area varies from mediterranean for most of the area, to steppe in scattered foothill and inland basin areas, to alpine in the high Sierra, to desert in the Colorado and Mojave Deserts.

The Pacific Ocean and its maritime air masses have a heavy influence on the climate. The effect of abrupt changes in topography on temperature range, wind velocity and precipitation amount and frequency results in wide variations often within a few miles. The Sierra Nevada and the Cascade Range effectively act as barriers for the movement of continental air masses from the east.

Two of the usual four seasons dominate the EIS area: a dry, warm summer and a cool, wet winter season. Winter lasts from October to April in the north and from November to March in the southern portion.

Winter storms from the west bring precipitation which falls as rain in the valleys and foothills and as snow in the mountains. Precipitation increases from south to north and falls heaviest on the west side of the mountains below 6,000 feet. When the snowpack melts in the spring, the heaviest runoff descends the west side of the mountains. Eastern mountain slopes fall into typical "rain shadows."

Snow is the major form of precipitation in high, forested, mountainous areas. It can be expected in the Sierra Nevada at any elevation above 2,000 feet during October to May. Above 4,000 feet, snow will remain on the ground for long periods of time, and at even higher elevations will be present all winter.

Air quality problems in some parts of the EIS area are unique and more severe than those found in any other portion of the country. Some of the most predominant air quality problems are caused by photochemical pollutants, created by reaction of directly emitted pollutants to ultraviolet sunlight.

The EIS area's air quality is affected by population, the types and number of pollutant sources, weather conditions and geography, all of which vary considerably from one region of the area to another. Generally, air quality is best in areas with low population density, such as rural areas of Northern California, and in mountainous regions at elevations higher than most commonly occurring temperature inversions.

Air quality is poorest in metropolitan areas and in locations downwind of them. Downwind locations often experience the worst air quality since local sources contribute to pollutant problems generated by sources elsewhere.

Various pollutants reach their peak concentrations during different times of the year. Concentrations of oxidant, sulfate and other pollutants that are the result of atmospheric photochemical reaction peak during the summer months. Concentrations of pollutants that are not formed photochemically, such as lead or carbon monoxide, are highest in winter months.

The predominant air quality problem in California's central valleys is excessive concentrations of particulate matter. In the San Joaquin Valley, annual average concentrations of particulate are double the State's air quality standards and are influenced primarily by agricultural operations.

Although air quality problems exist in urban areas such as Los Angeles and Riverside, the air quality in the EIS area is generally good overall.

There are provisions in the Clean Air Act Amendments of 1977 to ensure that air quality does not deteriorate in areas with clean air. Class I areas such as national parks and wilderness areas, allow virtually no deterioration. Most of the EIS area is Class II, which allows moderate deterioration of air quality.

GEOLOGY AND TOPOGRAPHY

The EIS area can be divided into fairly distinct geomorphic provinces dependent upon the geologic and climatic history of each area (Oakeshott 1971). The Sierra Nevada is a huge granitic mountain range on the area's eastern side, which has a gently sloping western slope, while the sheer eastern face drops off abruptly. The Central Valley lies on the western side of the Sierra Nevada, a vast sedimentary alluvial plain which is the drainage basin for most of California's rivers flowing out of the mountains. On the eastern side of the Sierras, the basin-ranges form an area of parallel mountains and basins experiencing harsher climatic extremes.

The northern portion of the EIS area is composed of the Klamath Mountains, the Cascade Range, and the Modoc Plateau. The Cascades are a chain of volcanic cones dominated by Mount Shasta at an elevation of 14,162 feet. The Modoc Plateau is an interior draining platform consisting of a thick accumulation of lava flows and tuff beds with many small volcanic cones. Along the California border with the Pacific Ocean are a series of more or less parallel mountain ranges and valleys which compose the Coast Ranges. Many active fault zones, including the San Andreas Fault, occur throughout the length of these ranges.

In the southern portion of the EIS area, the Transverse Ranges are distinguished by a strong east-west trend in contrast to the north-south pattern of all other geomorphic regions. This area is also a series of ranges and valleys running parallel away from the coast. California's southernmost mountains are the Peninsular Ranges with a geological profile like the granitic Sierra Nevada, but a topography similar to the Coast Ranges. A low-lying basin, the Colorado Desert, is directly east of these ranges. Part of the desert lies below sea level. The Mojave Desert stretches across the southeastern part of California, a vast area of isolated mountains separated by expanses of dry plains.

More detailed geologic and topographic information may be obtained from BLM State, District, and Resource Area Offices in the EIS area.

SOILS

Soil development is a function of the parent material, slope, climate and plant cover over time. These factors of soil formation have produced a myriad of different soils. The soils in the EIS area are highly variable in depth, texture, stoniness, chemical and physical properties. This broad range of characteristics implies a wide variation in drainage, permeability, erodibility, inherent fertility, water-holding capacity and any other soil property that is important to nutrient cycling and decomposition of organic compounds such as herbicides.

Soil surveys have been completed, are under way, or are planned on most BLM lands in the EIS area. This soil information is on file at BLM and Soil Conservation Service Offices throughout the EIS area.

WATER RESOURCES

SURFACE WATER

The BLM lands of the EIS area contribute to the flow of all the major rivers in California, but more directly affect the flow of ephemeral, intermittent, and small perennial creeks and rivers. These smaller streams flow both into major rivers and into closed basins such as the desert basins, Eagle Lake, Honey Lake, and Owens Valley. Many small springs and seeps important for wildlife and livestock are also found on the public lands.

Surface water is an important resource throughout the EIS area. Large amounts are used by municipal, domestic, agricultural, and industrial users. Nonconsumptive uses include uses for fisheries, recreation, aesthetics, hydropower generation, transportation, and water quality maintenance. BLM-administered lands contribute to or lie within many watersheds important for municipal supplies. While water contributed to the total flow of the area is relatively small it is often very important for maintaining natural systems for wildlife and aesthetic purposes.

Water quality and the beneficial uses of water are protected by Federal statutes and Executive Orders, State statutes, and agency regulations and directives developed to implement this body of law.

The State Water Resources Control Board and Regional Water Quality Control Boards are responsible for establishing water quality standards/objectives which protect the beneficial uses of different waters from adverse effects by any point discharge as well as nonpoint discharges (through Best Management Practices) into State waters.

The Bureau of Land Management (BLM) is required by Public Law 92-500 and Executive Order 12088 to meet State water quality standards regardless of the management activity. Even where no water quality standards have been established by a State, Federal law mandates that the BLM conduct management activities in such a manner as to protect or enhance water quality. Best Management Practices (BMP) would be applied to vegetation management activities to protect water quality on a site-by-site basis.

GROUNDWATER

Groundwater quantity and quality in the EIS area vary greatly and are normally a direct product of the geologic formation in which the groundwater originates. There are about 500 groundwater basins within the EIS area. The best aquifers are found in alluvial deposits along major streams. The following present and/or potential groundwater quality problems have been identified by the staff of the nine State Regional Water Quality Control Boards: salt water intrusion; salt accumulation; overdraft; general chemical problems; industrial chemicals; agricultural chemicals; and metals (SWRCB 1982).

Groundwater basins underlying significant areas of public land are often minimally developed for groundwater use due to their distance from high use areas or because of the yield or quality characteristics of the aquifer. The recharge area of many of the aquifers underlying BLM land is often in nonpublic land areas, i.e., National Forest lands or alluvial deposits under privately owned lands. The quality usually reflects the natural situation as most aquifers under BLM lands are unimpacted by the heavy uses which normally result in degraded groundwater water quality.

VEGETATION

TERRESTRIAL VEGETATION

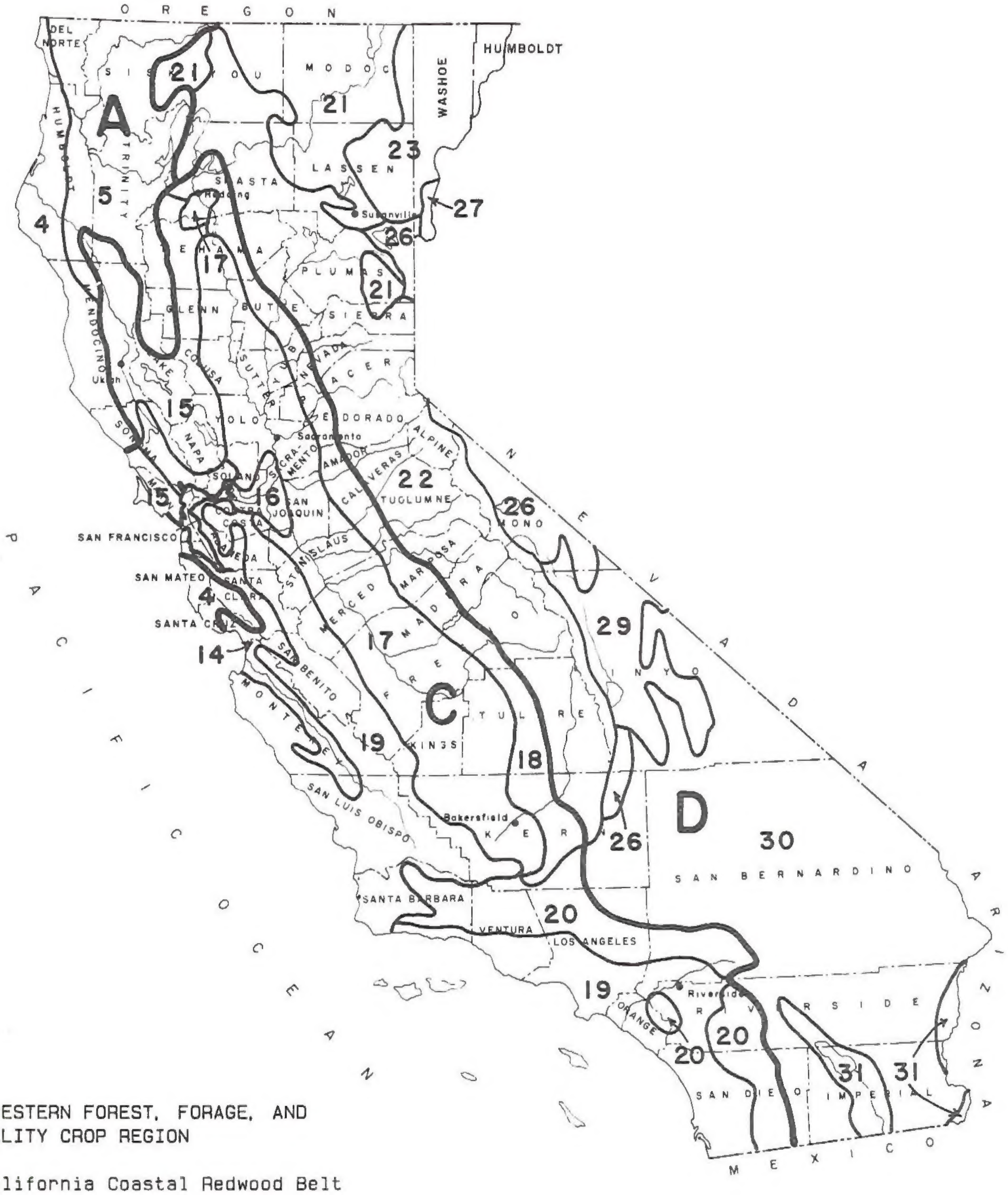
The assemblage of vegetation communities present in California and northwestern Nevada is complex. This is due in large part to the diverse topography of the immense land area and the wide spectrum of climatic conditions to which it is subject. The EIS area ranges from the redwood belt of the north coast to the expansive deserts of southern California. The plant communities found over this broad range present an array of problems for managing competing vegetation and controlling undesirable plant species. This section will briefly describe the EIS area by land resource regions and major land resource areas (USDA, SCS 1981). Major land resource regions are shown in Figure 2-1. The relationship of plant communities to the various regions and areas can be found in Table 2-1. Appendix I contains the scientific name equivalents of the common names listed below.

Northwestern Forest, Forage and Speciality Crop Region

This region is best described as steep mountains with narrow to broad gently sloping valleys. It supports forests, open forest and grassland vegetation. Public lands in the region occur within two major land resource areas (MLRAs): California Coastal Redwood Belt and Siskiyou-Trinity Area. Dominant tree species include redwood, Douglas-fir, grand fir, white fir, red fir, lodgepole pine, ponderosa pine, sugar pine, western red cedar, incense cedar, alder, California bay, chinquapin,

Figure 2-1

LAND RESOURCE REGIONS and MAJOR LAND RESOURCE AREAS



A	NORTHWESTERN FOREST, FORAGE, AND SPECIALITY CROP REGION

4	California Coastal Redwood Belt
5	Siskiyou-Trinity Area

C	CALIFORNIA SUBTROPICAL FRUIT, TRUCK, AND SPECIALTY CROP REGION

14	Central California Coastal Valleys
15	Central California Coast Range
16	California Delta
17	Sacramento and San Joaquin Valleys
18	Sierra Nevada Foothills
19	Southern California Coastal Plain
20	Southern California Mountains

D	WESTERN RANGE AND IRRIGATED REGION

21	Klamath and Shasta Valleys and Basins
22	Sierra Nevada Range
23	Malheur High Plateau
26	Carson Basin and Mountains
27	Fallon-Lovelock Area
29	Southern Nevada Basin and Range
30	Sonoran Basin and Range
31	Imperial Valley

SOURCE: U.S.D.A., SOIL CONSERVATION SERVICE
AGRICULTURE HANDBOOK 296

Table 2-1

Relationship of Vegetation Types* and Plant Communities* to Land Resource Regions and Major Land Resource Areas

Land Resource Region	Vegetation Type	Plant Communities	Major Land Resource Area
Northwestern Forest, Forage and Specialty Crop Region	Strand	Coastal Strand	California Coastal Redwood Belt
	Scrub	Northern Coastal Scrub	California Coastal Redwood Belt
	Coniferous Forest	North Coastal Coniferous Forest	California Coastal Redwood Belt
		Redwood Forest	California Coastal Redwood Belt
		Douglas-fir Forest	California Coastal Redwood Belt/ Siskiyou Trinity Area
		Yellow Pine Forest	Siskiyou Trinity Area
		Red Fir Forest	Siskiyou Trinity Area
		Lodgepole Forest	Siskiyou Trinity Area
	Mixed Evergreen Forest	Mixed Evergreen Forest	California Coastal Redwood Belt
	Grassland	California Coastal Prairie	California Coastal Redwood Belt
California Subtropical Fruit, Truck and Speciality Crop Region	Scrub	Alkali Sink	Sacramento and San Joaquin Valleys
	Coniferous Forest	Yellow Pine Forest	Sierra Nevada Foothills
	Woodland-Savanna	Northern Oak Woodland	Central California Coast Range
		Foothill Woodland	Central California Coast Range/ Sierra Nevada Foothills
	Chaparral	Chaparral	Central California Coast Range/ Sierra Nevada Foothills
	Grassland	Valley Grassland	Central California Coast Range/ Sacramento and San Joaquin Valleys
Western Range and Irrigated Region	Scrub	Sagebrush Scrub	Klamath & Shasta Valleys & Basins/Malheur High Plateau/Carson Basin & Mts.
		Shadscale Scrub	Southern Nevada Basin and Range/ Sonoran Basin and Range
		Creosote Bush Scrub	Southern Nevada Basin and Range/ Sonoran Basin and Range
		Alkali Sink	Southern Nevada Basin & Range/Sonoran Basin & Range/Carson Basin & Mts.
	Coniferous Forest	Yellow Pine Forest	Sierra Nevada Range/Klamath & Shasta Valleys & Basins
	Desert Woodlands	Northern Juniper Woodland	Malheur High Plateau
		Pinyon-Juniper Woodland	Southern Nevada Basin &Range/Sonoran Basin & Range/Carson Basin & Mts.
		Joshua Tree Woodland	Southern Nevada Basin and Range/ Sonoran Basin and Range

*(Munz and Keck, 1959)

madrone, tanoak, Oregon white oak, California black oak, and canyon live oak. Characterizing the forest understory are poison-oak, snowberry, ceanothus and manzanita. California oat grass, blue wildrye, bluegrasses, tufted hairgrass, velvet grass, western and Idaho fescues, and native and introduced bentgrasses are common perennial grasses. Important naturalized annuals include soft chess and other bromes, fescues, filaree, wild oats, and clovers. Typical vegetation management actions within this region are timber management site preparation, release of commercial species (i.e., hardwood suppression), precommercial thinning and stump treatments.

California Subtropical Fruit, Truck, and Speciality Crop Region

This region is characterized by low mountains and broad valleys with long, warm growing seasons and relatively low precipitation. Containing from small to moderate amounts of public land are three MLRAs: Sierra Nevada Foothills, Central California Coast Range, and Sacramento and San Joaquin Valleys.

The EIS area within the region is comprised of forests, oak woodlands, brushlands, and naturalized annual grasslands. Public land forests within the region are restricted to the Sierra Nevada Foothill MLRA. Dominant species include Douglas-fir and ponderosa pine with incense cedar often occurring as a subdominant. Some hardwoods such as California black oak, canyon live oak and big-leaf maple also occur. Beneath the forest canopy, poison-oak is frequently abundant.

Brushland sites are dominated by chamise, manzanita, ceanothus and poison-oak. Scrub oak, coyote brush and California sagebrush are also found on scrubby sites but are most common within the Central California Coast Range and Southern California Coastal Plain MLRAs. Soft chess, bromes, fescues, wild oats, wild barley, filaree and burclover characterize the naturalized annual grassland. Common oak woodland overstory species are blue oak, live oak and digger pine. The ground cover of the oak woodland is very similar, if not identical to the naturalized annual grassland. Saltgrass, iodine-bush and various species of saltbush occur along the valley floor on saline-sodic sites, especially in the southern San Joaquin Valley.

Vegetation control treatments common within the region are: prescribed burning of brushlands; removal of vegetation near geothermal and oil and gas well pads, drilling sites, power plants, and rights-of-way; eradication of noxious weed species; and timber management practices previously described.

Western Range and Irrigated Region

With the exception of the Sierra Nevada Range MLRA, this region can be typified as arid semidesert and desert comprised of plateaus, plains, basins and isolated mountain ranges. Public land acreage within the south-eastern portion of the region is extensive. The EIS area includes the following MLRAs: Klamath and Shasta Valleys and Basins, Sierra Nevada Range, Malheur High Plateau, Carson Basin and Range, and Sonoran Basin and Range. Public land forests within the region are found within the Sierra Nevada Range MLRA. Dominant tree species include ponderosa pine, incense cedar, sugar pine, white fir, red fir, lodgepole pine, mountain hemlock, California black oak, Oregon white oak, canyon live oak, and tanoak.

Sagebrush, blue wildrye, fescues, bluegrasses and mountain brome occur as ground cover below the forest canopy. Vegetation control measures utilized in this area are analogous to those discussed previously for timber management.

Comprising a portion of the public land of northeastern California and northwestern Nevada is the Malheur High Plateau MLRA. The area can be characterized as sagebrush scrub. Big sagebrush, bitterbrush, rabbitbrush, squirreltail, bluebunch wheatgrass, Great Basin wildrye, and needlegrasses dominate the area. Spiny hopsage and bud sagebrush dominate the drier sites. Greasewood, saltbush and saltgrass are found where soil salinity or alkalinity is elevated. Silver sagebrush is found on moist sites with intermittent water (e.g., playas). Rocky sites support western juniper. Aspen groves are found on the more mesic high elevation sites.

Also occurring in northeastern California are the shrub and grassland associations of the Klamath and Shasta Valleys and Basins MLRA. It is typified by bluegrasses, Idaho fescue, bluebunch wheatgrass, and cheatgrass. Dominant shrubs include sagebrush, rabbitbrush, bitterbrush and mountain mahogany. Western juniper is also common. Ponderosa pine and Douglas fir are found in zones of higher precipitation.

Farther south within the region occurs the Southern Nevada Basin and Range MLRA. The area is basically a shadscale scrub community, which is dominated by saltbush species and greasewood. Associated species include bud sagebrush, gray molly kochia, spiny hopsage, ephedra, dalea, winterfat, horsebrushes, galleta, Indian rice grass, black sagebrush, big sagebrush, black brush, bitterbrush and cliffrose. Shadscale is associated with creosote brush, white bursage, spiny mendora and Joshua tree in warmer locations. Saline soils are dominated by black greasewood. Pinyon-juniper woodlands occupy upland mountain sites.

The Carson Basin and Mountains MLRA is characterized by a sagebrush-grass complex. Common components are bitterbrush, squirreltail, needlegrasses and Indian ricegrass. Typical on mid-mountain slopes are pinyon-juniper woodlands, while at the highest elevations Jeffery pine, lodgepole pine, red fir, and white fir are found. Drier sites support shadscale. Growing in areas of high concentration are basin wildrye, alkali sacaton, saltgrass, black greasewood, and rabbitbrush.

The Sonora Basin and Range MLRA encompasses the southeastern portion of the State. This area supports plant communities of the Mojave and Colorado deserts. Bursage, Joshua tree, juniper, yucca, cactus, creosote brush and ephedra dominate the perennial flora. Ephemeral forbs and grasses occur during favorable rainfall years. Saline sites are dominated by saltbush, saltgrass, alkali sacaton and iodinebush. Grasses commonly occupying sandy sites include Indian rice grass, desert needlegrass and galleta.

Vegetation control measures typically practiced within the region (exclusive of the Sierra Nevada Range MLRA) include: tamarisk eradication along desert riparian zones; prescribed burning and mechanical treatments of sagebrush scrubland and northern juniper woodlands for rangeland improvement; and herbicide use for control of competing vegetation within sagebrush communities to increase livestock and wildlife forage.

NOXIOUS WEEDS

Twenty-one Category A and B noxious weed species occur on public lands within the EIS area. Herbicides were employed for the control of these noxious weeds on 140 acres of public lands in 1985. Manual and mechanical methods have been historically used as well. A list of noxious weed species occurring on public land can be found in Appendix B.

WETLANDS AND RIPARIAN AREAS

Wetlands and riparian areas occur along lakes, ponds, marshes, rivers, and streams. They are often inundated by water and normally have saturated or seasonally saturated soil conditions. Common wetland and riparian area plants range from cottonwoods and willows, to sedges, rushes, and cattails. The width of the areas may vary from a few feet along small streams to several hundred feet along major rivers. Because of the presence of moisture and abundant nutrients, wetlands and riparian areas are often the most productive areas of vegetation growth. They are valuable for wildlife habitat. The Bureau has a strong commitment to responsible management of these areas.

In the arid or semiarid lands of the EIS area, wetlands and riparian areas make up a small percent of the total land surface. However, weedy species (e.g., tamarisk) present a serious problem to the long-term management of these sensitive areas.

THREATENED, ENDANGERED AND SENSITIVE PLANT SPECIES

Presently, six plant species occurring on public land within the EIS area (reference Table 2-2) are included in the Federal list of species threatened or endangered of extinction (Federal Register, Vol. 50, No. 188, September 1985). Two others have been officially proposed for Federal listing. In addition, 61 State-listed species occur or are suspected to occur on public lands within the EIS area. It is Bureau policy to conserve Federal- and State-listed rare, threatened, or endangered plants and to utilize its authorities in furtherance of the purposes of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), and similar State laws. The BLM, through its actions and/or decisions, will not jeopardize the continued existence of any Federally listed threatened or endangered plant, nor will it destroy or adversely modify Critical Habitats (as determined by the Fish and Wildlife Service) of any such species.

It is also Bureau policy within California to protect sensitive plant species (see Glossary). Pending formal listing, all sensitive plants will be afforded the full protection of ESA unless the State Director judges on a case-by-case basis that evidence against listing a particular plant species is sufficient to allow a specific action. Currently, 148 sensitive plant species occur on public land within the EIS area. Appendix J contains a list of Federal and State-listed plants and sensitive plant species.

Table 2-2

Federally Threatened, Endangered and Proposed Plant Species Within EIS Area

Species	Family	Federal Status	BLM District
Arabis *mcdonaldiana* Eastw. Mcdonald's rockcress	Brassicaceae	Endangered	Ukiah
Camissonia *benitensis* Raven San Benito evening-primrose	Onagraceae	Threatened	Bakersfield
Centrostegia *leptoceras* (Gray) Wats. Slender-horned spineflower	Polygonaceae	Proposed	Calif. Desert
Eriastrum *densifolium* ssp. *Sanctorum* (Mlkn) Mason Santa Ana River eriastrum	Polemoniaceae	Proposed	Calif. Desert
Grindelia *fraxino-pratensis* Reveal and Beatley Ash Meadows gum plant	Asteraceae	Threatened	Calif. Desert
Nitrophila *mohavensis* Munz and Roos Amargosa nitewort	Chenopodiaceae	Endangered	Calif. Desert
Oenothera *avita* ssp. *eurekensis* (Munz and Roos) Klein Eureka Dunes evening-primrose	Onagraceae	Endangered	Calif. Desert
Swallenia *alexandrae* (Swallen) Soderstrom and Decker Eureka Dune grass	Poaceae	Endangered	Calif. Desert

FORESTED AREAS

About 755,000 acres of the total 18.6 million acres of Public Domain land in California and northwest Nevada are forested, while 216,000 acres are capable, suitable, and available for commercial timber production. The lands most likely to be affected by vegetation management for forest reestablishment and maintenance are commercial forestlands in northern California.

Under direction from the Federal Land Policy and Management Act of 1976 and other Federal laws, and Sustained Yield Unit Records of Decision, the public domain lands within California currently have an allowable cut of 21.6 million board feet (MBF). Annual sales vary, depending on budgets, market conditions, bidder interest, and size and quality of sale. Harvests have varied even more depending on new housing starts, Congressional extensions to timber sales, and the generally poor timber market during the last several years.

The timber management program for California is documented and described in detail in the Environmental Impact Statements for Sustained Yield Units 8 (King Range) (USDI, BLM 1974) and 13 (Clearlake and Arcata Resource Areas of Ukiah District) (USDI, BLM 1981b) and in the Environmental Assessment for Sustained Yield Unit 15 (Susanville and Bakersfield Districts, Redding Resource Area of the Ukiah District, Carson City District lands in California) (USDI, BLM 1981c).

Since those documents were completed a substantial change in land base as well as the timber stand structure has occurred in SYU 13. The major change which affects treatments proposed in this EIS is that lands acquired as a result of exchanges are largely inadequately stocked and have heavy brush and hardwood stocking levels.

The allowable cut for BLM lands in California is presently 21.6 million board feet per year. This level assumes that intensive forest vegetation management practices will be applied as needed. Without intensive management the allowable cut would have to be reduced by an estimated 25 percent. Intensive management practices include site preparation, planting, plantation maintenance and release, and precommercial thinning but do not include different harvesting methods to ensure natural reproduction. It is estimated that the use of herbicides is the only viable method available to maintain 10 percent of the allowable cut.

Forest management plans, EISs, and current practices on BLM forestlands in California emphasize multiple uses of the forestlands. This decision as well as the current stand structure allows cutting practices other than clearcutting in most cases. Cutting practices other than clearcutting tend to prevent invasion of sites by brush and therefore lessen the need for control of unwanted vegetation control.

All-aged as well as even-aged management systems are used. The all-aged system is used mainly in the eastside or interior ponderosa/Jeffrey pine type and in areas of special concern (e.g., wild and scenic river corridors, highly erodible soils, harsh sites, etc.). Trees are selected in small groups or individually and are marked for harvest. Regeneration is accomplished mainly by natural means and/or by planting openings and areas disturbed by logging activity.

Even-aged management systems involve stand regeneration done by clearcutting trees (all trees removed from the site), shelterwood, and seed tree methods. Clear cuts are limited in size to 40 acres. Typically clearcuts are between 10 and 12 acres in size. The acreage that requires reforestation each year consists mostly of clearcut sites and areas burned by wildfire.

The four main stages of vegetation management for reforestation are site preparation, planting, release, and precommercial thinning. Under current policy, during the next 10 years a total of about 700 acres would be prepared and planted each year, about 1,000 acres would be released from competing vegetation, and 400 acres would undergo precommercial thinning. Release would occur within 2 to 5 years of planting and precommercial thinning within 10 to 20 years. Some stands may require two release treatments. These practices are explained in detail in Appendix C.

Over many decades most of the forestlands that are allocated primarily to timber production in the EIS area would come under even-aged management. The cumulative effect of the entire timber program would be to convert that acreage into even-aged stands (consisting of trees of the same age within each stand) in various stages of growth. The average rotation length (maximum stand age) would be about 120 years.

Five major forest types comprise the commercial forestlands within California. Individual areas within extensive stands of each type may vary greatly in vegetative composition, depending on aspect, soil, and other factors.

DOUGLAS-FIR FOREST

This forest type is located in the Coast Range from Mendocino County northward, mostly east of the redwood forest type, and to elevations of 4,500 feet. This type occurs in the Northwestern Forest, Forage and Specialty Crop Region. Average annual rainfall ranges between 30 and 100 inches, and the growing season lasts up to seven months.

Besides Douglas-fir, the principal associated conifers are sugar pine and white fir. The main associated hardwood trees and shrubs are tanoak, madrone, golden chinquapin, big-leaf maple, California black oak, California hazel, deer brush, and snowbrush.

YELLOW PINE FOREST

Eastside Pine

This forest type is found in a nearly continuous belt east of the Cascade and Sierra Nevada Ranges from the Oregon line to the Tehachapi Mountains. South of the Sierra Nevada Range, the type occupies the crests of the higher mountains. This type occurs primarily within the Western Range and Irrigation Region. Precipitation varies from 15 to 40 inches annually. The growing season is only about four months.

Conifer species are ponderosa pine, Jeffrey pine, white fir, and lodgepole pine. California black oak, junipers, and pinyon pine are sometimes components of this type. The more common associated shrubs include sagebrush, bitterbrush, mountain mahogany, manzanitas, and snowbrush.

Westside Pine

This forest type occurs primarily on the western slopes of the Sierra Nevada and Cascade Ranges as a transition belt of varying width between the foothill woodlands at lower elevations and the mixed conifer forest at higher elevations. This type occurs primarily within the Northwestern Forest, Forage and Specialty Crop Region. Annual precipitation ranges from 30 to 80 inches. The growing season is approximately seven months.

Ponderosa pine dominates and is the climax species of this forest type. Associated conifers are Jeffrey pine, sugar pine, Douglas-fir, white fir and incense cedar. Some of the principal shrubs and hardwood trees are deer brush, bearclover, whiteleaf manzanita, greenleaf manzanita, California black oak, and canyon live oak.

MIXED EVERGREEN FOREST

This forest type is found in the North Coast Range at elevations from 300 to 6,000 feet; in north-central California from 1,200 to 5,500 feet; in the Sierra Nevada from 2,000 to 7,000 feet; and in southern California at elevations from 5,000 to 8,000 feet. This type occurs primarily in the Northwestern Forest, Forage and Specialty Crop Region. The prevailing climate is similar to, but cooler than, that of the Pacific ponderosa pine type.

The principal conifer species are: ponderosa pine, sugar pine, incense cedar, Douglas-fir, and white fir. Jeffrey pine occurs mostly on serpentine soils. Some of the principal associated hardwood tree and shrub species of the type are California black oak, Sierra currant, bearclover, greenleaf manzanita, whiteleaf manzanita, Mariposa manzanita, deer brush, snowbrush, mountain whitehorn, and bush chinquapin.

RED FIR FOREST

This forest type occurs above 6,000 feet in the North Coast Ranges; in north-central California from 5,500 to 7,500 feet; and in the Sierra Nevada from 6,000 t0 9,000 feet. It occurs in the Northwestern Forest, Forage and Specialty Crop Region. Annual precipitation mostly snowfall, is 35 to 65 inches. The principal conifer species are red fir, lodgepole pine, sugar pine, western white pine, and Jeffrey pine. Principal shrubs in the type are bush chinquapin, mountain whitehorn, snowbrush, greenleaf manzanita, and pinemat manzanita.

WOODLAND TYPE

Of the 755,000 acres of forestland (land composed of or capable of being composed of at least 10 percent stocking (crown closure) with tree species) under BLM's jurisdiction in California and northwest Nevada 539,000 acres are classified as woodlands or low site timberland. The low site timberlands are composed of both commercial species and noncommercial species. For management purposes these lands are generally grouped together and managed as woodlands and will be referred to as woodlands throughout this document.

The woodlands are primarily used for fuelwood production, timber production, posts, grazing, wildlife, and other multiple uses as directed or authorized by land management plans, FLPMA, or other authority.

Western juniper occurs as a pure woodland type in northeastern California and northwestern Nevada and comprises nearly two-thirds of the woodlands (350,000 acres) in the area covered by this EIS. Pinyon in combination with junipers (mostly Utah juniper) makes up another 10 percent of the total. Both of these types (taken together are known as PJ) occur intermingled with the eastside yellow pine type and out into the big sagebrush type. Together they comprise about 75 percent of the woodlands. The PJ type has been increasing in acreage during the past 80 years and appears likely to continue. Much of the management activity in this type has been and is likely to continue to be directed at controlling this encroachment. Presently juniper woodland production exceeds demand for products such as fuelwood except near localized areas of utilization.

The remaining 25 percent of woodlands consists of various hardwoods adjacent to or intermixed as described in the primary forest types as well as mountain mahogany and aspen in the eastside yellow pine areas. There is considerable demand for hardwoods for fuelwood, but sustained yield of public land hardwoods does not meet these demands.

WILDLIFE

WILDLIFE HABITAT

More than 600 species of mammals, birds, reptiles and amphibians live, or at least meet part of their life requirements on public lands in California and northwestern Nevada. Wildlife populations are managed by the California Department of Fish and Game and the Nevada Department of Wildlife. BLM manages their habitats.

Wildlife species are associated with certain kinds of habitats; vegetation is an important component of habitat. Wildlife habitats are often described in terms of plant communities and successional stages to facilitate evaluation of effects on habitat caused by vegetation management activities. Certain areas like fawning and nesting grounds, migration corridors, and winter ranges are especially important to some species.

Public lands in California and northwestern Nevada include a variety of habitats, including 7.3 million acres of big game habitat, 13.4 million acres of small game and upland game habitat and 235,000 acres of wetland and riparian habitat. Wildlife diversity and the occurrence of rare or unique species and habitat values are among the highest found anywhere on BLM lands. Table 2-3 lists some of the major big game species found in the EIS area and estimated populations on public land.

Table 2-3

Big Game Species and Populations on Public Lands
in California and Northwestern Nevada

Species	Estimated Population on Public Land
Pronghorn Antelope	6,500
Mule Deer	78,000
Black-tailed Deer	33,000
Tule Elk	900
Roosevelt Elk	100
Bighorn Sheep	3,000
Wild Boar	2,600
Black Bear	700

Pronghorn antelope occur in the Great Basin sagebrush habitats on the east side of the Sierra Nevada and Cascade Ranges. Pronghorn are mainly browsers, feeding primarily on sagebrush especially during the winter. Grasses and forbs are important during the spring.

Black-tailed deer and mule deer are the most common, widely distributed, and hunted big game species on public lands in the EIS area. Riparian areas provide important fawning and escape cover for deer.

Tule elk utilize the sagebrush/scrub habitats of the Owen's Valley and the chaparral areas along Cache Creek. Roosevelt elk are found primarily in the King Range on the north coast of California.

Bighorn sheep are almost exclusively limited to desert mountain ranges in southeastern California. BLM lands provide year-round habitat for both peninsular and Nelson's bighorn.

Wild boar are found in the coastal chaparral and are a popular game species.

Upland game birds found on public lands include: sage grouse found primarily in the sagebrush habitats in northeastern California and northwestern Nevada; chukar found on rocky slopes in northeastern California and in the California desert; wild turkey which utilize oak woodlands; and dove and quail found throughout the State.

Most of the EIS area's waterfowl are migrant, short-term occupants, following the Pacific flyway during spring and fall. Some waterfowl overwinter near unfrozen water. Nesting waterfowl species of the EIS area include mallard, Canada goose, teal, gadwall, pintail, and shovellers.

Many stockponds, reservoirs, streams, and rivers provide extensive acreage of shoreline and riverbank nesting and feeding habitat required for the existence of shorebirds. Great blue herons, gulls, grebes, snipe, lesser yellowlegs, willets, avocets, terns, sandpipers, killdeer, and long-billed curlews all nest in the EIS area. Many of these species migrate through the area in spring and fall.

The northeastern region of the EIS area is a winter concentration area for golden eagles and rough-legged hawks, which depend upon rabbits as their major winter food source. Bald Eagles congregate in winter roosts near rivers and lakes in the EIS area. Bald and golden eagles, red-tailed hawks, kestrels, marsh hawks, and great-horned owls are all known to nest in the area. The turkey vulture and prairie falcon are also common residents.

Cliff areas, rock outcrops, and shrubs provide nesting sites for most of these raptors. In open country, utility poles, fenceposts, isolated trees, rock outcrops, and other isolated structures provide important perches for hunting raptors. These perches are often well used along transportation routes where traffic-killed small animals are an attractive food source.

Many seed-eating and insectivorous birds inhabit riparian and upland vegetation zones, but little information exists on their densities, distribution, and limiting factors in the EIS area. Woodpeckers and other cavity-nesting birds depend on dead trees for their existence.

The habitats most likely to be affected by vegetation management are sagebrush, chaparral, Mediterranean annual grasslands and early successional stages of coniferous forests. Effects of vegetation management on wildlife habitats are considered in every project environmental assessment. Changes in plant cover will benefit some species and adversely affect others.

FISHERIES HABITAT

Many game fish species inhabit the EIS area, including salmon, steelhead, rainbow trout, brown trout, smallmouth bass, largemouth bass, crappie and catfish.

Anadromous fish (steelhead and salmon) support both commercial and recreational fishing. BLM lands contain only about 10 percent (735 miles) of the stream habitat for anadromous fish in California. However, much of this habitat (489 miles of stream) is high quality spawning and rearing habitat. Declines in anadromous fish populations have been attributed to both adverse effects on habitat and direct harvest of fish.

Fish habitat consists of an aquatic environment and the associated riparian environment. Vegetation management can affect both environments. The effects of vegetation management on fish habitats are considered in project environmental assessments.

THREATENED, ENDANGERED, AND SENSITIVE ANIMALS

Fifteen federally listed threatened and endangered species are known to occur on public land in California and northwestern Nevada (Table 2-4). Any action that may affect these species is subject to formal consultation with the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act.

Within the EIS area, there are at least 284,000 acres and 20 miles of stream habitat providing important habitat for these species. There are an additional 11 species on the State threatened and endangered species lists (Table 2-4). Habitat management activities are given priority to ensure their continued survival.

BLM has also developed a list of sensitive species which includes: desert bighorn sheep, spotted owl, flat-tailed horned lizard, gila monster, desert tortoise, San Sebastian leopard frog, Inyo Mountain salamander, Amargosa River pupfish, Nevada speckled dace, Shoshone cave whip scorpion, and San Joaquin dune beetle. The spotted owl occurs in the Ukiah District and the San Joaquin dune beetle is found in the Bakersfield District. The remainder of these species inhabit the Desert District.

BLM sensitive species are afforded special consideration to ensure that their populations do not decline to the point where listing as threatened or endangered becomes necessary.

Vegetation management must consider the potential effects on all special status species in project environmental assessments to ensure that the continued existence of any of these species is not jeopardized.

LIVESTOCK AND WILD HORSES

Livestock grazing (cattle, sheep, horses and goats) is a primary use of BLM lands in the EIS area. The EIS area had approximately 125,000 head of livestock on BLM lands during 1985 that grazed on about 9 million acres of land, consuming roughly 387,000 animal unit months (AUMs) of forage. Livestock grazing in the EIS area has been covered in detail by 18 site-specific grazing EISs and Resource Management Plans.

The Wild Free-roaming Horse and Burro Act of 1971 (Public Law 92-195) provides for the protection, management, and control of wild free-roaming horses on BLM lands. The EIS area has 35 wild horse management units to provide forage for approximately 2,600 horses and 2,800 burros.

CULTURAL RESOURCES

Federal agencies have been charged with responsibility for managing cultural and paleontological resources on lands under their jurisdictions. Through a group of laws beginning with the Antiquities Act (1906) (Chap. 3060), BLM has been mandated to identify, protect, and enhance such resources on public lands.

Table 2-4

Threatened and Endangered Animals on Public Land in California and Northwestern Nevada

Species	Federal Status	State Status	BLM District
San Joaquin Kit Fox	E	T	Bakersfield
Southern Sea Otter	T	--	Bakersfield
Fresno Kangaroo Rat	E	E	Bakersfield
Amargosa Vole	E	E	Desert
California Condor	E	E	Bakersfield, Desert
Bald Eagle	E	E	Bakersfield, Ukiah, Susanville
American Peregrine Falcon	E	E	Bakersfield, Ukiah
Yuma Clapper Rail	E	T	Desert
Blunt-nosed Leopard Lizard	E	E	Bakersfield
Coachella Valley Fringe-toed Lizard	T	E	Desert
Desert Slender Salamander	E	E	Desert
Mohave Tui Chub	E	E	Desert
Owen's River Pupfish	E	E	Bakersfield
Paiute Cutthroat Trout	T	--	Bakersfield
Desert Pupfish	E	E	Desert
Mohave Ground Squirrel	--	T	Bakersfield, Desert
Stephen's Kangaroo Rat	Cand.	T	Desert
Wolverine	--	T	Bakersfield, Ukiah, Susanville
California Bighorn Sheep	--	T	Bakersfield
Peninsular Bighorn Sheep	--	T	Desert
California Yellow-billed Cuckoo	Cand.	T	Bakersfield, Desert
Elf Owl	--	E	Desert
Inyo Brown Towhee	Prop.	E	Desert
Least Bell's Vireo	Prop.	E	Desert
Magic Gecko	Cand.	T	Desert
Shasta Salamander	Cand.	T	Desert

In many cases surveys of existing cultural resource information (Class 1 inventories) have been completed for areas of BLM Districts and may be examined in the BLM District Offices.

Many archaeological, historical, and paleontological sites have been found on or near BLM-administered land in the EIS area. Some of the information has been lost from all of these sites as a result of natural or human disturbances before discovery. Future intensive surveys are certain to locate many more sites. The identified archaeological sites range from small special purpose sites or seasonally used campsites to major long-term village sites. Most historical sites relate to early settlement, transportation, mining, and logging. Paleontological resources in the EIS area include many vertebrate, invertebrate, and plant fossil sites. Lists and descriptions of known paleontological sites on or near BLM lands are maintained by BLM District Offices.

VISUAL RESOURCES AND RECREATION

Visual resources consist of the land, water, vegetation, animals, and other natural or manmade features visible on public lands. Highways, rivers, and trails of the area pass through a variety of characteristic landscapes where natural attractions such as mountain vistas can be seen and where cultural modifications exist. To enable visual resources to be considered when planning management, public lands have been assigned visual resource management (VRM) classes according to scenic quality, sensitivity level, and distance zone criteria. VRM classes provide objectives designed to mitigate adverse impacts of land management practices on scenic values (BLM Manual 8400). VRM maps and narratives derived from inventories and evaluations of visual resources on public lands may be examined in respective BLM District Offices.

Among the outdoor recreation activities occurring on BLM lands in the EIS area are sightseeing, picnicking, camping, fishing, and hunting. Other popular activities are off-road vehicle use, horseback riding, river floating, and the studying of natural features. Some of these activities, such as camping and picnicking, occur at recreation sites that require vegetation control. Detailed information on recreational use of public lands may be obtained at BLM District Offices.

WILDERNESS AND SPECIAL AREAS

BLM California's preliminary recommendation is approximately 2 million acres out of 6.9 million acres as suitable for wilderness designation. The majority of the 6.9 million acres is the 5.5 million acres of wilderness study areas in the California Desert Conservation Area (CDCA), of which BLM has recommended 1.8 million acres as suitable pending the assessment of mineral survey data. The U.S. Bureau of Mines and the U.S. Geological Survey are expected to complete the mineral reviews by September 1988.

By the end of 1987, all California BLM wilderness studies are expected to be completed. Recommendations will be forwarded to the Secretary of Interior by BY 1988 upon assessment of USGS/Bureau of Mines mineral reports.

The California Wilderness Act of 1984 designated five BLM wilderness areas in the State.

ECONOMIC CONDITIONS

BLM administers roughly 18.5 million of the EIS area's 102 million acres, or 18 percent of the land base. The 1980 population was 23.7 million.

Vegetation control activities generate employment and personal earnings in the local economy. The level and effectiveness of vegetation control on BLM land in the area could prevent the spread of noxious weeds to productive land, increase livestock forage, improve wildlife habitat, and increase forest productivity.

The production of timber, livestock, and crops generate employment and earnings in the regional economy. Vegetation control allows production to take place and also contributes to more economic activity in the regional economy from control expenditures, and also reduces economic losses from fire.

During fiscal year 1986 total receipts of 72 million dollars from public land activities was realized (USDI, BLM 1987b). Of the total most was from mineral activities with $1,010,000 from timber sales and $500,000 from grazing receipts. While the timber and grazing receipts are an insignificant portion of the total earnings of these two activities statewide, they are very significant to specific rural areas and the households supported by these activities on public land.

SOCIAL ENVIRONMENT

The social environment affected by BLM's vegetation control program includes individuals; the companies and businesses they work for; the communities, organizations, and groups they have formed; and their agencies and institutions of government. The social environment also includes attitudes, opinions, and perceptions about vegetation control policies and practices. For this EIS, BLM did not undertake a detailed social analysis of the EIS area that included a population profile, demographic analysis, institutional analysis, or formal public opinion survey. During the past several years, however, BLM has conducted studies in the EIS area, with extensive public involvement, for several EISs and many environmental assessments. The following description of the social environment that could be affected by BLM's vegetation control program is based on that information and on concerns expressed during scoping for this EIS.

In addition to direct impacts on jobs and personal income, certain social aspects of employment might be affected by BLM's programs: the importance of certain types of jobs to specific communities, dependence on particular jobs, availability of alternative jobs, access to jobs, and a community's level of acceptance of certain types of work. For example, some people highly depend on a certain type of work; for some people, alternative jobs do not exist, access to alternative jobs is limited, or alternative jobs are perceived as inappropriate work. The social effects of job losses are more significant for these people than for those who are flexible and have access to alternative jobs.

A significant social issue related to BLM's vegetation management program is public concern over the use of herbicides and their effects on human health. Opponents of herbicide use perceive a BLM bias in favor of herbicides. The opponents see BLM as an advocate of herbicide use, defending that position rather than seeking public input to the process of decision-making. The proponents see BLM abandoning what they believe to be a demonstrably safe and effective means for controlling noxious weeds and competing vegetation.

The controversy has opposing factions whose points of view are sometimes unaffected by the other side's perceptions of data. BLM is in the middle, having to make decisions that best serve a larger public interest encompassing much more than this controversy. The full extent and intensity of the controversy among the people of the EIS area are not known.

On one side of the controversy the decreased production for timber and grazing and the spread of noxious weeds is also a concern. Some are concerned with (1) the spread of noxious weeds from BLM lands onto private, State, and other public land; (2) the economic losses from this encroachment and competition; and (3) the effects of noxious weeds and undesirable plants on native vegetation. Public interest also exists in cooperative programs of weed control. Concern over the spread of noxious weeds is expressed by county and State laws enacted to control noxious weeds.

The controversy is sustained by the following four factors. First, EPA has approved the chemicals for use and has provided instructions for safe handling and application. For some people this is the whole story. They see no basis for opposition to herbicide use and they also see no reason for BLM to limit herbicide use or to entertain observations that the herbicides used for controlling weeds are used more often and in larger amounts for agriculture and home use than for control of noxious weeds and competing vegetation. The agricultural use however does not generate comparable opposition.

Another factor is that some people are suspicious of the accuracy of EPA's determinations about herbicides. They fear that the approved herbicides may eventually be found to be as dangerous as other substances previously thought to be harmless. By then, they reason, it will already be too late to avert at least some harmful consequences.

A third factor that sustains the controversy is the difficulty in establishing scientifically, in a way that is comprehensible and believable to concerned individuals and interest groups, either the presence or the absence of cause and effect relationships between herbicide use and environmental damage or between exposure to herbicides and human health problems. This complicated scientific situation is important in three ways. In some cases (especially concerning long-term effects), the scientific evidence may simply be inconclusive. Therefore, questions concerning the effects of using a particular chemical, though they appear to be scientific questions, may have to be answered today in social and political terms. Conclusive scientific analyses may not be completed for years. Second, some segments of the public may distrust or reject sound scientific conclusions because they cannot understand the analytical process leading to the conclusions or because they have come to consider all scientific studies concerning herbicides to be inconclusive or dubious. Finally, some people criticize the fact that many studies of the health effects of herbicides are based on research with laboratory animals whereas their direct experiences of perceived impacts on people and wild and domestic animals seem to be ignored. A more extreme manifestation of this problem arises when parties to the controversy do not even agree on the identification of credible sources of information and analysis or on the definition of legitimate scientific research.

A fourth factor that helps sustain the controversy about herbicide use is that some people are increasingly concerned about not having control over their larger environment, including the management of BLM land resources. There is a growing sense that the nonprofessional public has a legitimate interest in how these land resources are managed. A traditional attitude of "leaving resource management to the professionals" is becoming less prevalent, and increasing numbers of people seem to want some say in how professionals do their job. Just as social factors are linked to economic conditions, social factors are linked to other components of the environment such as air and water quality, rare and endangered plants, wildlife and recreation, and human health and public safety issues. For example, some are concerned about the safety of workers and the health of those directly or indirectly exposed to chemicals, with or without awareness of the exposure. Some are also concerned about contamination of water sources that are eventually used for irrigation, stock watering, domestic water supply, and fish hatcheries. These fears and anxieties appear to be directly related to the perception of scientific uncertainty about the existence of health risks.

CHAPTER 3

ENVIRONMENTAL CONSEQUENCES

CHAPTER 3

ENVIRONMENTAL CONSEQUENCES

Chapter 3 compares environmental consequences (impacts) of three alternatives to the existing environment as described in Chapter 2 and analyzes the significant impacts resulting from implementing each alternative in relation to these baselines. (Table 1-4 compares composite impacts of each of the three alternatives.) Analysis, including the scoping process, reveals that the proposed program for controlling vegetation would not significantly affect climate, geology, topography, minerals, utilities, communication sites, paleontological resources, energy requirements, or prime or unique farmlands. Therefore, these topics are not discussed.

Basic assumptions of the analysis in Chapter 3 include the following: (1) that BLM will have the funding and personnel to implement the final decision, (2) that all design features described in Chapter 1 and Appendix D will be applied, and (3) that the types and amounts of treatments will be applied as shown in Table 1-1. The program is intended to be in effect for 10 years.

In this EIS, short-term and long-term are defined as follows:

Short-term: the 10-year period following the initial implementation of a noxious weed program.

Long-term: beyond the 10-year period.

IMPACTS ON AIR QUALITY

Air quality could be adversely affected by chemical drift from herbicide treatment, herbicide volatilization, fugitive dust from manual and mechanical treatment, and particulates and visible smoke from prescribed burning.

Air in the atmosphere serves as a carrier of chemical spray drift from aerial, ground hand, and ground vehicle herbicide spraying. Liquid spray droplets most prone to chemical drift are usually 100 microns or less in diameter (spray equipment is designed to produce 200 micron droplets). These small droplets may be carried downwind great distances before reaching the ground, or lofted upward and carried even greater distances. If such a cloud of tiny droplets remains concentrated enough upon reaching the ground, physical damage may be done to a nontarget vegetation species on which it descends. Such a situation is normally found when there is severe temperature inversion and little wind velocity. On the other hand, if air-mixing and lofting of the chemical material to higher altitudes occur, it is entirely possible that particles will be sufficiently scattered and degraded to not pose a problem (California Weed Conference 1985).

Although herbicide applications result in vapor losses, commercial uses have not shown volatility to lead to phytotoxicity (see Glossary) in non-target plants (NRCC 1974 in USDI, BLM 1985a). Loss from volatilization is reported to be negligible or insignificant with asulam, bromacil, dalapon, fosamine ammonium, glyphosate, hexazinone, simazine, and tebuthiuron. Minor loss from photodecomposition and/or volatilization of atrazine is not fully understood. It has been reported that atrazine is more subject to ultraviolet light and volatility losses than simazine (Weed Science Society of America 1983). Volatilization of 2,4-D will depend on the particular formulation of 2,4-D, with acids and amines being less volatile than esters, which vary from high to low with the oil soluble amines being considered the least volatile. Dicamba may volatilize from soil surfaces but further study is required to determine the extent of such losses. Studies of diuron have suggested that photodecomposition or volatility losses are insignificant except when diuron is exposed on the soil surface for several days or weeks under hot, dry conditions. Breakdown of picloram occurs in ultraviolet light. The rate of this breakdown is greatest in clear, moving water and on soil and plant surfaces. Triclopyr losses due to volatilization are not appreciable (Weed Science Society of America, 1983).

Fugitive dust generated from the use of heavy equipment in mechanical treatments or from manual treatments usually has only a localized and short-term impact on air quality and visibility. Since Alternative 3 has the greatest amount of mechanical treatments, dust problems would be greatest under Alternative 3, and Alternative 2 would be slightly worse than Alternative 1 as far as dust impacts are concerned.

Increases in particulates and visible smoke are major impacts to air quality expected to result from prescribed burning. Because the Proposed Action (Alternative 1) and Alternatives 2 and 3 propose 26,000 acres per year for prescribed fire treatments in the entire EIS area, particulates and visible smoke are expected to moderately increase on a short-term, localized basis. Because prescribed burning will be conducted during periods of instability, the National Ambient Air Quality Standards (see Glossary) for particulate concentrations are not expected to be exceeded, even in nonattainment areas under any alternative.

Although burning would be conducted so as to protect population centers and Class 1 areas from smoke, unforecasted weather changes could cause smoke to reach these locations. With the application of smoke management, the probability of such an occurrence is extremely low primarily because of the conditions proposed for prescribed burning and the use of improved burning techniques such as pretreatment of vegetation by mechanical or chemical means, use of a backing fire or use of the helitorch.

In conclusion, air quality impacts from chemical drift and volatilization are expected to be short term and restricted to the localized area and time of the treatment because of application during conditions of low wind speed and moderate temperature. Fugitive dust impacts from manual and mechanical treatments are restricted to the treatment site. The use of smoke management technology will minimize air quality impairment from prescribed burning.

IMPACTS ON SOILS

Soils could be adversely affected by herbicide, manual, mechanical, and prescribed burning treatments.

Removal of solid stands of vegetation by chemical treatment may result in short-term, insignificant increases in surface erosion that would reduce as vegetation reoccupies the treated site.

The behavior of a chemical substance in the soil is determined by several properties relating both to the chemical and to the soil environment (Heilman et al. 1979). The persistence of biological activity at the usual rate of herbicide proposed for use is summarized in Table 3-1 and discussed in Appendix F. In general, arid soils would have longer herbicide persistence than other soils. Impacts on soils from herbicide applications would be greatest under Alternatives 1 and 2 but nonexistent under Alternative 3, however the use of the 16 chemical herbicides under Alternatives 1 and 2 would not degrade soil productivity when used at approved application rates.

Table 3-1

Persistence of Biological Activity at the Usual Rate of Herbicide in Moist-Fertile Soils, Summer Temperatures, in Temperate Climate[1] (Klingman and Ashton 1982, Weed Science Society of America 1983)

1 Month or Less (Temporary Control)	1-3 Months (Early-Season Control)	3-12 Months[2] (Full-Season Control)	Over 12 Months[3] (Total Vegetation Control)
Amitrole	Hexazinone	Atrazine	Bromacil
Asulam	Triclopyr	Dicamba	Picloram
Dalapon		Diuron	Tebuthiuron
2,4-D		2,4-DP	
Fosamine ammonium		Simazine	
Glyphosate			

[1] Approximate values based upon available data.

[2] At higher rates of application, some of these chemicals may persist at biologically active levels for more than 12 months.

[3] At lower rates of application, some of these chemicals may persist at biologically active levels for less than 12 months.

Manual treatment includes the use of simple hand tools for hand grubbing, cutting, and girdling operations such as the saw, axe, shovel, machete, mattock and brush hook. Machines available for use in manual treatment include chainsaw, tree girdler, and scythette. Hand grubbing involves digging out plants from the soil with as much of their root system as necessary to prevent sprouting and regrowth. Cutting and girdling insignificantly impact soil. Hand grubbing could provide short-term, localized slight increases in erosion in treated areas until vegetation reoccupies the area.

Mechanical treatment includes brush chipping, dozing, chaining, crushing, mowing and tilling. Brush chipping and mowing would have localized impact of a slight to moderate increase in soil compaction where heavy equipment was used. Chaining, dozing, and crushing do not materially increase runoff and erosion but leave debris and trash to protect the soil from erosion. Some localized impact of soil compaction could occur however, affecting infiltration and runoff. Tilling would have the most impact on soils, but impacts are relatively short term until vegetative cover has been reestablished on the treatment site. Ripping compacted areas and judicious placement of water bars could effectively mitigate effects of soil compaction from heavy equipment usage (Vallentine 1980). Due to the larger amount of disturbed area Alternative 3 would have the greatest level of impact from mechanical treatments and Alternatives 2 and 1 would have successively less erosion.

All alternatives would involve prescribed burning. The effects of prescribed fire would be directly related to the duration and intensity of the burn as well as on-site characteristics. The use of prescribed fire could minimize the effects of high soil temperatures associated with a wildfire that can cause significant changes in surface soil properties, in particular organic matter content, water repellancy, and soil microbial populations. Some short-term insignificant declines in soil productivity in the treated area is expected from loss of soil organic matter which is a major source of nitrogen and sulfur in the soil. The destruction of some soil microorganisms could slightly reduce soil productivity also, but impacts would be minor and short-lived because prescribed fires would not involve the intense fires that reduce microorganisms most dramatically (Wells et al. 1979). Short-term increases in erosion could occur until vegetation reoccupies the treated area. Overall magnitude of prescribed burning impacts can be minimized by: burning under weather and fuel conditions that result in a low intensity burn, selection of treatment areas with soil types, topography, physiography, and climate that are best suited to minimize damage to soils, burn when the soils are moist, limiting chaining and crushing preparation work to slopes less than 30 percent, and leave sparsely vegetated areas greater than 50 percent slope unburned.

In summary, chemical residues on soil surfaces may persist and be leached into the soil profile. The probability and extent of persistence and leaching depends on formulations (water solubility), soil moisture, timeliness of rainfall after herbicide application, soil permeability and relative affinity of the herbicide for the soil colloid and/or organic matter fraction. Manual or mechanical methods could on a short-term basis increase soil compaction, disturb soil surfaces and therefore increase erosion. Prescribed fire could produce short-term impacts on soil productivity and erosion until soil microorganisms and vegetation have reoccupied the burn site. These impacts can be minimized by following prescriptions that reduce damage to soils. In the long term erosion on prescribed burn areas would be more stable than if uncontrolled wildfires occurred.

IMPACTS ON WATER RESOURCES

Alternatives 1 and 2 would have varying impacts on water resources, including the possible introduction of herbicides into water and an increase in suspended sediments and dissolved solids. The degree of impact would depend on the size of the treated area, closeness to water, existing water quality, and type of treatment.

IMPACTS ON SURFACE WATER

The likelihood of a herbicide entering surface water depends upon the herbicide's persistence and mobility (see Glossary and Impacts on Soils). Herbicides would most likely enter streams through drift (see Impacts on Air Quality). Some herbicides could also enter streams in surface runoff or through erosion of previously treated soils.

In areas where large streamflows occur, such as in the Sierra Nevada and northwestern California, herbicides entering streams are heavily diluted so that little if any herbicide is detected. In arid or semiarid areas, the normal streamflow is low or ephemeral. Where streamflow results from thunderstorms, surface runoff may flush herbicide residuals into streams in detectable levels. The amounts would depend upon the length of time since spraying in which microbial action has been degrading the herbicide (see Impact on Soils). The longer the interval, the less chance of residuals being present.

The environmental fate on the 16 proposed herbicides is briefly discussed in Appendix F and for more specific information, the reader should refer to Agriculture Handbook Number 633 (USDA, Forest Service 1984) or to studies accumulated by Labat-Anderson Incorporated (1986).

Since herbicide drift is far more variable during aerial spraying, the amount of herbicide drift that reaches the water is expected to be greater with aerial applications and proportionately less with ground hand and vehicle applications. Often no effort is made to exclude aerial spraying across ephemeral stream channels. In these instances rainfall may flush herbicide residues downstream when little time has passed since spraying.

Ground vehicle application produces much less drift than aerial application, and ground hand application would produce little or no drift. Therefore, if herbicides originating from hand application reach the stream channels, it is usually through surface runoff.

Alternative 2 would result in little herbicide reaching a stream through drift. Surface runoff would move less residual spray because less acreage would be involved and spray entering buffer zones could be better controlled. Thus, less residue would exist for movement into streams.

Alternative 3 would result in no herbicides from BLM actions reaching the stream channel.

Normal BLM herbicide applications, using standard controls such as buffer strips, would not affect suspended sediments, total dissolved solids, or water temperature. Other actions under Alternatives 1, 2, and 3, however, such as manual, mechanical, and prescribed burning treatments, could affect water resource conditions.

Physical restrictions on mechanical treatments (such as on steep slopes) and buffer strips next to surface water would limit significant impacts to water quality. Short-term increases of suspended sediments in water could be expected under all alternatives with Alternative 3 having the highest level of sediment introduced to streams.

Prescribed burning generally destroys most or all vegetation. This removal of vegetative cover would increase the potential of surface runoff and might increase suspended sediment and total dissolved solid levels in streams. The size of the impact from this treatment would depend on amount of exposed soil, severity of the burn, and distance to the nearest stream. On the other hand prescribed burns to reduce fuel loading reduce the chances of wildfire caused floods and erosion.

Prescribed burning would also provide the beneficial impact of greater water yields. Small springs and streams near burned areas often produce greater amounts and flow longer into the summer, due to less water consumed by vegetation. This increase in flow would primarily benefit resident wildlife and livestock as increases would not be significant enough for downstream uses.

IMPACTS ON GROUNDWATER

Since amitrole, asulam, bromacil, 2,4-D, 2,4-DP, dalapon, dicamba, hexazinone, tebuthiuron, and triclopyr are relatively mobile herbicides, the potential exists for detectable traces to enter the groundwater. The relative immobility of glyphosate prevents it from moving down into the soil profile (see Appendix F). The degradability of atrazine, diuron, dicamba, 2,4-D, fosamine, picloram and simazine highly depend on microbes in the soil and water. The number of microbes decreases as herbicides percolate down through the profile. Groundwater contains few if any microbes to carry on the degradation.

No herbicides applied on BLM-administered lands have been reported to reach the groundwater.

Streams and wetlands are areas where the groundwater often occurs close to the surface. These areas are also high in microorganisms. With use of buffer strips spray would reach these areas only by drift. Because the amount of herbicides in these areas is low and the microorganisms in these areas are high, no significant impacts are expected to groundwater.

WATER RESOURCES SUMMARY

Site-specific environmental analysis conducted before herbicide application will address sensitive areas, including areas where herbicides could be introduced into the streams or groundwater recharge areas. These areas may require mitigation or no treatment at all. Through the required site-specific evaluations and application of standard procedures it is unlikely that any significant (detectable) amounts of herbicide will be introduced into streams or groundwater. There will be short-term impacts to erosion and sedimentation from mechanical and prescribed burn treatments, but these will be offset by the long-term reduction of erosion and sedimentation caused by uncontrolled wildfires. Alternatives 2 and 3 would result in the most noticeable impacts to water resources due to the greater amount of mechanical treatments.

IMPACTS ON VEGETATION

TERRESTRIAL VEGETATION

Management of competing vegetation would have both beneficial and adverse impacts on terrestrial vegetation within the EIS area. Both target and nontarget vegetation in areas scheduled for treatment would be directly affected. The degree to which vegetation would be affected would depend on the types of treatment used and the number of acres treated under each alternative (see Table 1-3). The overall effect of managing competing vegetation would be to accelerate succession for forest management, to achieve desired seral stages in rangeland management situations, to create stratified age structure dynamics in brushlands and chaparral for wildlife habitat improvement and fuel hazard reduction, and to reduce or eliminate populations of undesirable species in eradication programs.

Prescribed Burning

Under all alternatives an average of 26,000 acres per year would be treated. Impacts on competing vegetation from burning would be identical under all alternatives.

Forest Management

Prescribed burning would primarily be used for site preparation. Under all alternatives the acreage proposed is relatively small (100 acres per year).

Burning would temporarily eliminate or suppress competing vegetation, improving conifer survival. By exposing mineral soil, however, burning would also promote the subsequent invasion of grasses, forbs and hardwoods. The germination of some competing shrubs such as manzanita and ceanothus would be stimulated by burning, most often in the mixed evergreen and coniferous forests.

Intense burns would be more likely to kill plant roots than light burns. Lightly burned areas would have a higher percentage of herbaceous and brush cover present within two years after burning. However, growth of this vegetation would be delayed, providing more competitive free growing time for conifers than would be available in most unburned areas. It is estimated that 80 percent of the treatment area would be lightly burned.

Risk of wildfire from escaped slash burns would be the same under all alternatives. Data from western Oregon indicate that only 4.5 percent of BLM slash burns resulted in wildfire from 1980 to 1982 (USDI, BLM 1983). In California BLM-initiated prescribed burns over the last 10 years only one escape has occurred (Franklin, 1986).

Rangeland Management, Fuel Hazard Reduction, and Vegetation Removal

Prescribed burning employed for range improvement, wildlife management, fuel hazard reduction and vegetation removal will primarily occur in chaparral communities (14,900 acres per year under all alternatives). Proposed burning within sagebrush scrub and northern juniper woodlands is of a smaller magnitude (11,000 acres per year under all alternatives).

Burning within chaparral would suppress brush species in the short term, increasing community age diversity and the number of species present. Fire within this community induces a series of successional changes beginning with an herbaceous ground cover in the first year. Long-term effects on species diversity is dependent upon burn timing. Winter and spring burns (wet season) could reduce or eliminate species that depend upon seeds for reproduction while crown sprouting shrubs would increase. Fall (dry season) burns will have no adverse effect on grass and herbaceous vegetation seed sources.

Prescribed burning within sagebrush scrub and northern juniper woodlands would lead to the short-term removal or suppression of overstory competing vegetation, improving survival and vigor of the more desirable forage plants. Most of the burns would not be intense enough to kill plant roots. Fire treatments would result in reduced competition and subsequent perennial grass release for approximately 3-8 years dependent upon the site's potential (Willard Phillips, Personal Communication). Grass species generally would be positively affected with increased vigor and density.

Burning would be used mostly to control sagebrush. Big sagebrush is a non-sprouter and is highly susceptible to fire injury. The burning of sagebrush would reduce total plant cover; however, the elimination of sagebrush competition would allow for rapid revegetation of the bare ground surface by the existing native vegetation. There would be a short period after the burn during which the site would be susceptible to invasion of undesirable plants such as cheatgrass and medusahead.

Research indicates that needlegrass is the grass most susceptible to damage by burning. The least detrimental effects on needlegrass would occur with a cool and fast fire, good moisture, and burning being conducted in the fall of the year when the plant is dormant (Wells et al. 1979).

Plants are generally most susceptible to fire damage during growth phases when root reserves are low and least susceptible during periods of dormancy. Reseeding is generally not needed after prescribed burns. Soil, vegetation, and topographic conditions generally allow for a natural revegetation of the burn area.

Chemical Treatments

Forest Management

Herbicides impact the species composition, size, density, and vigor of vegetation. Impacts on vegetation would range from complete control to negligible damage depending on species, chemicals used, dosages and timing of applications.

Herbicides used for site preparation, maintenance and release (e.g., picloram, triclopyr, glyphosate, and atrazine) would usually result in a large percentage of brush and hardwood defoliation, a fair amount of topkill (see Glossary) and minimum resprouting. Treatments would not necessarily eliminate all competing vegetation but would temporarily reduce competitors, increasing the amount of light reaching conifers and decreasing brush and grass competition for soil moisture and nutrients. Impacts of herbicides would be greater on plant sprouts or seedlings than on full-crowned, mature plants.

Chemical release would increase the growth rate of young conifer seedlings stressed by competing vegetation. Western Oregon studies on use of selected herbicides for Douglas-fir release show a significant increase in both tree height (Gratkowski and Lauterback 1974) and diameter (Lauterback 1967).

Oil carriers would also impact vegetation. In addition to improving spray coverage and herbicide penetration, diesel carriers in themselves could damage or kill plants. Occasional damage would occur to individual conifers which began bud break earlier than the majority of conifers in a spray unit.

Herbicide injection for precommercial thinning would leave trees standing and would generate a dense slash layer from dead needles. This would increase fire hazard, the laddering of fuels, and increase potential of injury to conifers. Herbicide injection could also adversely affect released conifers if chemicals were absorbed through root contact with injected trees.

Based on acreage proposed for treatments, impacts of herbicides on vegetation would be greatest under Alternative 1 (Proposed Action), and less under Alternative 2 with no herbicide impacts under Alternative 3. Under Alternative 1, nontarget vegetation immediately adjacent to spray units could be adversely affected by herbicides drifting beyond unit boundaries. Such impacts would be mitigated by buffer strips and application techniques (Gratkowski 1974).

Rangeland Management, Fuel Hazard Reduction, and Vegetation Removal

The overall objective of managing competing vegetation with use of herbicides would be to improve ecological condition and natural plant composition, provide for more favorable herbage production, improve watershed protection, enhance wildlife habitat, pretreat prescribe burn areas, control noxious weeds and certain undesirable plant species, and to remove vegetation.

The herbicides proposed for prescribed burning pretreatment, sagebrush control and tamarisk eradication are selective yielding no adverse effects on grasses. Herbicide (picloram) used in tamarisk eradication may kill or damage interspersed nontarget trees through translocation of herbicides from tamarisk roots to soil to other roots. Vegetation removal needs (e.g., rights-of-way, pipelines, drilling pads, administrative sites, etc.) will be accomplished with broad spectrum, nonselective herbicides that would affect most perennial plants, annuals and biennial grasses, sedges, rushes and broadleaf plants. Maximum weed control measures may require either selective or nonselective chemicals depending upon individual situations.

Nonselective herbicide use would result in the greatest loss on target vegetation. Since chemical drift could injure or kill nontarget vegetation, herbicides would not be applied when weather conditions would defeat their effectiveness or when controlling the treatment would be problematic. With all herbicide use, some chemical residue may be left for varying periods, depending upon soil and climatic conditions.

Before prescribed burns chaparral brush species can be chemically pretreated to achieve a dead-to-live fuel ratio between 1:3 and 1:2 (Green 1981). The herbicides proposed for this type of use (picloram, triclopyr and 2,4-D) are applied in late spring. A single treatment kills roughly one-third of crown-sprouting brush species, but may completely kill more sensitive brush species such as ceanothus and salvia (Green 1981). Full effect of treatments can take from several weeks to a few months.

Herbicide use in sagebrush communities would generally result in brush defoliation and a minimum of resprouting. Treatments would not necessarily eliminate all competing brush species but would reduce competition, thereby increasing the amount of light reaching the surface and decreasing competition for soil moisture and nutrients.

In sagebrush scrub situations where selective herbicides (e.g., 2,4-D and picloram) would be used, broadleaf plants would be the main target group affected. Plants such as rabbitbrush, greasewood, mountain mahogany and many forbs in or near treatment sites could be weakened or destroyed.

The extent of any nontarget vegetation loss would depend on the proximity of desirable species, both foliage and roots, to treated target plants, method and rate of herbicide application, formulation of the herbicide, and herbicide used. Herbicide application rates would be reduced in riparian areas to mitigate injury to nontarget plants.

Most grasses would resist applications of the expected use rates of picloram, dicamba, 2,4-D amine and ester formulations, tebuthiuron, and triclopyr. Grasses commonly would become more abundant in the short term as plant competition is reduced following range vegetation control. Vigor would also improve due to more favorable moisture and plant nutrient relationships.

Overapplication of herbicides, mixing mistakes, accidental spills, or misapplication would weaken or destroy nontarget vegetation. Timing of herbicide application would be important. Applications of some herbicides during early stages of growth could reduce grass production (USDA, FS 1984).

The herbicide application season for most effective target species treatment would occur when other desirable forbs and grasses are most susceptible to damage. However, this impact would be minimized by following proper application procedures.

Impacts to terrestrial vegetation from herbicides would be most profound under Alternative 1. This is due principally to the short-term adverse effect of aerial application of herbicides on nontarget vegetation. The effects of Alternative 2 would be less since no aerial chemical treatments would affect nontarget vegetation. Such impacts would be reduced by buffer zones and application techniques.

Species diversity in general will not be affected by the use of herbicides, in that, treatments are episodic rather than chronic. Long-term effects would be accelerated forest succession and improved vigor in rangeland communities. Any seeding or planting efforts would also affect species diversity however those actions are not a part of this evaluation.

Mechanical Treatments

Forest Management

Scarification would remove most of the brush in treated areas, killing over 70 percent of the root systems (Newton and Dost 1981). By exposing bare mineral soil, scarification would aid germination of light-seeded species such as grasses and hardwoods. On scarified units where grass establishes itself as the dominant vegetation, conifer seedlings would suffer increased moisture stress and damage from rodents and deer. Damage to conifers from animals could also increase if slash were piled during scarification and left unburned, because piles would provide excellent habitat for rodents. In addition, piling would impact conifer stocking by decreasing plantable acres.

Mechanical cutting (i.e. with Hydro-axe) would have little effect on root systems, increasing the incidence of sprouting. Many competing species such as bigleaf maple, tanoak, madrone and evergreen huckleberry would thrive on repeated cuttings and form dense, vigorous hedges of sprouts.

Scarification, piling and cutting would be most effective in controlling competing vegetation when used in combination with other site preparation methods. Scarification by itself would expose bare mineral soil aiding germination of light-seeded species, such as grasses and alder. Some shrubs would resprout from surviving root systems. The result would be open stands of hardwoods and brush surrounded by a dense cover of grasses and forbs (Newton and Dost 1981).

Impacts of mechanical treatments would be slightly greater under Alternative 3 (600 acres) and progressively less under Alternatives 2 (575 acres) and 1 (475 acres).

Rangeland Management, Fuel Hazard Reduction, and Vegetation Removal

Mechanical treatments such as chaining would remove most of the competing vegetation in treated areas, killing the majority of the root systems. However, mechanical treatment would also result in a greater amount of disturbance to desirable plant species (nontarget plants). This would allow undesirable plant species a greater chance to establish themselves. Reinvasion of competing vegetation could occur quickly even where seeding is included with mechanical treatment. Plant substrates would be adversely affected by mechanical measures. Reseeding with adapted native plants is recommended with tilling types of mechanical treatment in order to replace desirable native plants lost in the treatment process and to ensure effective revegetation with desirable plants and reduce soil erosion loss.

Impacts to rangeland vegetation as a result of mechanical treatments would be greatest under Alternative 3 (2,750 acres) and progressively less under Alternatives 2 and 1 (2,225 and 1,925 acres, respectively).

Manual Treatments

Forest Management

Manually cutting brush and hardwoods for both site preparation and release would temporarily reduce competition. However, studies and field observations in western Oregon indicate that within 6 months to 2 years after treatment, sprouts of competing species may regenerate to their original height, and brush density could increase significantly (Roberts 1980). These impacts would be most pronounced in the mixed evergreen forests due to the abundance of prolific sprouting species. In addition, manual cutting could result in injury to more than 20 percent of released conifers from saws, falling debris, and shock from exposure (Roberts 1980).

Mulching would prevent the growth of grass and increase available moisture to conifers. A 1982 study in western Oregon (USDI, BLM 1983) revealed a 93 percent survival rate on mulched plots containing Douglas-fir seedlings after three growing seasons. On slopes greater than 65 percent mulch could slip downhill and damage conifer seedlings.

Scalping would temporarily remove competing vegetation from individual planting spots. Vegetation with extensive root systems, particularly some grasses, would quickly regenerate in most areas. Occasional damage to seedlings could occur if scalping were done after planting. Overall, scalping would not significantly impact vegetation.

Impacts of manual precommercial thinning on vegetation would be similar to those of release treatments. Although some damage would occur to released conifers by accidental cutting or by falling trees, precommercial thinning could increase merchantable volume by 20 to 25 percent (Curtis et al. 1982). As with manual release cutting, manual precommercial thinning would leave a dense slash layer on the ground, creating a fire hazard for three to five years, but in some cases the slash could be prescribe burned without damage to the standing trees.

Rangeland Management, Fuel Hazard Reduction, and Vegetation Removal

Hand pulling and hand tools (shovel, hoe, pulaski) would be employed under all alternatives (Table 1-3). These methods are highly labor intensive, requiring periodic retreatment, ranging from every three weeks during the growing season to annually, depending on the target species. These methods have been somewhat successful in controlling annuals and biennials in noxious weed control and vegetation removal along rights-of-way, pipelines, etc. Manual treatments, however, have proven inefficient in controlling creeping perennials in these situations. Manual methods are impractical for large-scale rangeland improvement projects and prescribed burning pretreatment.

With this type of vegetation management treatment, some degree of weed control would be achieved, but most weeds (including many noxious species) would spread due to ineffective control efforts. Undesirable vegetation would increase.

Impacts to terrestrial vegetation would be greatest under Alternative 3 and less under Alternatives 1 and 2.

RIPARIAN HABITATS AND WETLANDS

Riparian habitats and wetlands are the most productive ecosystem within the EIS area. Additionally, from the standpoint of animal diversity and numbers of individuals per acre, these areas are probably the most important habitat type in the EIS area. Strict adherence to the project design features for riparian habitat and wetland protection would be required during any treatment which employed the use of herbicides near these important areas. If these features are followed, no long-term adverse impacts to these important habitats are likely to occur.

Principal herbicide treatment in riparian and wetland areas would be hand application of chemicals to the introduced exotic tamarisk. The potential minor adverse impacts from transfer of herbicide between roots to nontarget vegetation would be short term. Long-term effects of tamarisk removal would be positive and highly beneficial to the health of the ecosystem.

NOXIOUS WEEDS

Treatment of noxious weeds could affect both target and nontarget vegetation. Alternatives 1 and 2 would have the greatest effect on noxious weeds in the EIS area. Alternative 3 would have less effectiveness on noxious weeds.

Glyphosate, the least selective of the herbicides that would be used under Alternatives 1 and 2, would result in the greatest loss of nontarget vegetation. For dicamba, picloram, and 2,4-D, broadleaf plants would be the main nontarget group affected. Plants such as rabbitbrush, greasewood, mountain mahogany, sagebrush, willows, aspen, and many forbs in or near treatment sites could be weakened or destroyed.

The extent of any nontarget vegetation loss would depend on closeness of desirable species to treated weeds, method and rate of herbicide application, formulation of the herbicide, and herbicide used.

The most effective and efficient control of noxious weeds would be under Alternatives 1 and 2. Aerial application of herbicides within the EIS area is not proposed for noxious weed control. Alternatives 1 and 2, therefore, would have similar effectiveness and impacts for noxious weed control. Alternative 3 (no herbicide use) would utilize manual and mechanical control methods which are much less effective and much more expensive, but would have few impacts to nontarget vegetation.

THREATENED, ENDANGERED OR SENSITIVE PLANTS

Unidentified populations of threatened, endangered or sensitive plant species could be susceptible to any impacts described under terrestrial vegetation. Direct effects of injury or death to plants could cause the immediate elimination of a species in all or a significant portion of its range. The more subtle effects of vegetative community changes could cause the eventual elimination of a species on a specific site locally through loss of competitive ability relative to other vegetation.

If any species of vascular plant is determined by the U.S. Fish and Wildlife Service to be threatened or endangered, any action that would jeopardize its continued existence would be in violation of the Endangered Species Act of 1973, as amended. Furthermore, all sensitive species will be afforded the full protection of the Endangered Species Act (excluding formal Section 7 consultation) unless the State Director judges on a case-by-case basis that the evidence against listing a particular plant species is sufficient to allow a specific action.

Therefore, environmental analysis accomplished prior to any site-specific action would document any threatened, endangered or sensitive plant species known to be present on the site and identify appropriate measures to be taken to protect the species. If the EA determines that the project may affect any listed species, consultation pursuant to Section 7 of the Endangered Species Act would be undertaken.

VEGETATION SUMMARY

The overall impact of all alternatives would be to suppress competing vegetation. In a forest management context this means increasing conifer growth and survival to maintain productivity. For rangeland improvement the desired result is increased grass production for livestock, wild horses and grass-eating wildlife. Chaparral treatments will reduce fuel hazard and improve wildlife habitat.

The greatest levels of vegetation control would be provided under Alternative 1 (see Table 1-3) which would include the full range of vegetation management practices and would treat the largest number of acres through herbicide application. Adverse impacts to nontarget vegetation would also be greatest under this alternative.

Less impact on competing vegetation would occur under Alternative 2, which prohibits aerial application of herbicides. Alternative 3 would least impact competing vegetation resulting in the lowest level of conifer survival and rangeland improvement acreage.

Herbicides would provide greater control of resprouting vegetation than other treatments, particularly when applied prior to burning. Suppression of most competing vegetation through manual cutting would be temporary because sprouts would quickly regenerate, increasing brush density to above pretreatment levels. Mechanical treatments would temporarily remove competing vegetation from sites but would aid germination of grasses and hardwoods, in forest situations. Mechanical measures would also prove only marginally effective in rangeland management and vegetation control.

IMPACTS ON FORESTED AREAS

ALTERNATIVE 1, PROPOSED ACTION

Under the Proposed Action the annual allowable cut would be 21.6 million board feet for California. The Proposed Action assumes herbicide application on 900 acres per year over the next 10 years. This is higher than required for the long term because treatments have not been current for at least the last 30 years. After reducing the current backlog to zero the annual treatment acres by herbicides would drop by at least 50 percent.

ALTERNATIVE 2, NO AERIAL SPRAYING

Under this alternative the treatable acreage by herbicides would decrease to approximately 60 percent of the level for Alternative 1. Other types of vegetative treatments would not increase significantly because of economic inefficiency. That is, treatment would be foregone and reduction to the allowable cut would occur. The annual allowable cut would decrease to 20.5 million board feet and forest development costs would increase slightly over Alternative 1.

ALTERNATIVE 3, NO ACTION/NO HERBICIDES

Under this alternative the allowable cut would decrease by 20 percent to 17.3 million board feet. There would be a slight increase in total forest development costs as other more expensive methods are used to attempt to meet forest development needs. Although it is possible to meet these needs without herbicides it is expected that budgets will not allow it nor is it prudent management to spend unlimited funds to reforest some lands.

IMPACTS ON WOODLANDS

The woodlands are discussed as two distinct types, the juniper woodlands, and the hardwood woodlands.

Juniper Woodlands

Most of the prescribed burning program which is conducted in woodland types is in the big sage/juniper types. The primary reasons for these burns are to halt the encroachment of juniper into the big sage type and to improve range condition. Of the proposed annual treatment acres, approximately 1,000 acres of the big sage type includes at least 10 percent stocking of juniper. This is the minimum stocking level to be considered forestland or woodland in this case.

In the proposed action approximately 500 acres of big sage/juniper woodlands would be sprayed with herbicide for range improvement. The herbicide use is primarily to control sagebrush and although junipers may be sprayed they would only be slightly affected by the herbicide. Some kill on portions of juniper trees may occur but in most cases the entire tree would not be killed.

Harvest of juniper for fuelwood and posts removes the larger juniper from the equivalent of 200 acres per year in scattered patches. Much of this is concentrated and considered to be range improvement.

All three alternatives include prescribed burning and fuelwood harvests at the same level and since herbicide application has little effect on the junipers there is no difference in effect for the three alternatives considered.

Hardwood Woodlands

Hardwood woodland types are those which do not fall within the commercial softwood forest types. Therefore hardwood control within the commercial forest is not addressed in this section. There is no intention to control areas designated as hardwood woodlands under any of the alternatives, however they may be affected by the prescribed burning and spraying program in the chaparral types. These woodland types are often adjacent to or intermixed with the chaparral and would be unintended targets.

Prescribed burning in hardwood woodlands is constant for all three alternatives. Herbicide use to control the brush or chaparral species in Alternative 1 would have the most effect on the hardwood woodland types mainly due to herbicide drift. Alternatives 2 and 3 would have fewer impacts since spray can be directed where desired in Alternative 2 and none would be used in Alternative 3. Overall there would be no difference in effect on the hardwood woodland types because treatments can be well controlled and are not intended to be directed at these species. Any minor impact to woodlands from accidental burns would be offset by the beneficial effects of the chaparral management program, namely fire hazard reduction under all alternatives.

IMPACTS ON WILDLIFE

TERRESTRIAL VERTEBRATES

Impacts on wildlife from vegetation management would be both positive and negative, depending on the species affected and the type of treatment used. Quantified impacts on wildlife species will be identified in individual environmental analyses, when site-specific proposals are selected. In all cases, impacts on wildlife will essentially be the result of habitat alteration. No direct toxic effects are expected from the use of any of the herbicides proposed for use. A risk assessment related to possible toxic effects to wildlife and aquatic species has been done and is included in this document as Appendix L. The assessment found that risks to wildlife from chemicals would be low to negligible, with no likely effect to larger animals.

Chemical Treatments

Herbicides significantly modify wildlife habitat by suppressing certain forms of vegetation for the release of others.

Alternative 1

The reduction or elimination of big sagebrush on 3,000 acres per year would have mixed impacts on wildlife. Thermal and escape cover for deer and antelope would be reduced on any winter range treated. There may also be a loss of nontarget bitterbrush which would negatively affect deer winter range. However, sagebrush reduction would improve grass and forb composition. This would benefit both deer and antelope during the spring when nutrition is especially important for lactating does.

Spraying winter concentration areas or nesting grounds would be detrimental to sage grouse as thermal cover, food supply and nest sites are reduced. In general, spraying in big sagebrush tends to reduce habitat diversity and stratification which result in a corresponding reduction in nongame diversity. This impact is most significant in large treatment blocks.

Spraying of 1,700 acres of chaparral annually would generally benefit most species of wildlife. Dense, decadent chaparral currently provides low value habitat. Spraying when followed by prescribed burning of chaparral would open up areas of habitat currently unavailable to deer and would increase the amount of edge or ecotone. This would actually increase habitat and nongame species diversity. The localized loss of chaparral-dependent species would be insignificant due to the small percentage (0.02 percent per year) of this habitat type to be treated.

Chemical treatment of 1,150 acres of grassland per year would have no significant effects on wildlife. The majority of grassland control would be in small patches associated with rights-of-way, utility corridors, oil well pads and noxious weed control. Most sites would be less than 10 acres.

Herbicide application would generally have adverse effects on wildlife on 900 acres per year of forestlands. Suppression of grasses, forbs, brush and hardwoods would reduce habitat capability for all species using early seral stages. Deer use would increase temporarily, but long-term reduction in deer forage would occur. Nongame species diversity would decline as a result of reduced habitat (vegetation) diversity and stratification.

Chemical control of tamarisk on 150 acres annually would generally benefit wildlife. Dense stands of impenetrable tamarisk would be opened up for reestablishment of native riparian vegetation. This increased habitat diversity would yield a corresponding increase in animal species diversity. Overall condition of desert riparian habitats would be improved.

The majority of the impacts on the 6,900 acres of habitat annually affected by Alternative 1, would result from aerial spraying on 5,200 acres per year. Aerial spraying would be used for generalized control over fairly large tracts. Ground application of herbicides both by hand and by vehicle on 1,700 acres per year would retain more diversity by allowing for more selective control of target species on a more site-specific basis.

Exposure to acutely toxic levels of herbicides is not anticipated, as none of the herbicides proposed for use have been reported to be highly toxic to animals when used in accordance with manufacturers' labels (Weed Science Society of America 1983). Chronic effects of herbicides on wildlife are not anticipated. Animals are not likely to be exposed to repeated treatments, and herbicide residues ingested are excreted rather than concentrated in body tissues. See Appendix L for greater detail regarding toxic effects.

Alternative 2

Impacts on wildlife resulting from herbicide application would be similar in nature to those under Alternative 1. However, the level of impacts would be diminished by reducing the total of treatment areas to 1,950 acres per year. The magnitude of impacts would be further reduced by using only ground application which allows for increased selection for target species and the smaller average size of treatment. These impacts would affect sagebrush and chaparral habitats which would receive very little control compared to Alternative 1. Potential benefits to deer and nongame species in chaparral communities would not be realized.

Alternative 3

Not applying herbicides would eliminate the potential for adverse impacts on wildlife resulting from chemical vegetation control. However, the potential benefits to wildlife in chaparral and desert riparian areas would not be realized either. These areas would remain in unsatisfactory condition for wildlife.

Manual Treatments

Manual control of vegetation on 500 acres per year under Alternatives 1 and 2, or 1,200 acres per year under Alternative 3 would have no likely significant impacts on wildlife. Manual control methods are very selective for target species. Nontarget species and key areas can be easily avoided. Even treating 1,200 acres represents less than 0.01 percent of the wildlife habitat on public land within the EIS area.

Mechanical Treatments

Chaining, crushing, plowing, slash piling, etc., all reduce structural diversity. Food and cover for deer and a variety of nongame species would be reduced on 475 acres of forest habitats under the Proposed Action (575 acres and 600 acres under Alternatives 2 and 3).

Mechanical treatments on 1,425 acres of chaparral under Alternatives 1 and 2 (1,650 acres under Alternative 3) would benefit deer and nongame species by opening up dense, decadent brush fields. Habitat diversity would increase. Wildlife habitat would receive insignificant impacts in grassland and alkali sink habitats. Approximately 500 acres of this type are proposed for mechanical treatment annually under Alternatives 1 and 2 (700 acres under Alternative 3). These treatments would generally be in small areas, associated with rights-of-way and oil and gas well pads.

Impacts on wildlife resulting from mechanical treatment would be greatest under Alternative 3 (3,350 acres) and least under Alternative 1 (2,400 acres). Alternative 2 would impact 2,800 acres.

Prescribed Burns

Impacts on wildlife have been fully documented in the Chaparral Management Program Final Environmental Impact Report (CDF 1981), and numerous site-specific environmental analyses prepared by all District Offices in California. Overall impacts from prescribed burning are beneficial to wildlife populations. However, there are some short-term, localized losses of individuals of some species. Prescribed burning would affect 26,000 acres of wildlife habitat annually under all three alternatives

(14,900 acres of chaparral, 11,000 acres of sagebrush and 100 acres of forest are expected to be burned annually). This represents continuation of an existing, ongoing program. There would be no change from the existing situation resulting from prescribed burns under any of the alternatives.

FISH

Vegetation management can impact fish and aquatic habitat by causing changes in food supply, water temperature, water chemistry and bottom composition. Vegetation control, both chemical and mechanical can lead to increased sedimentation. This can reduce or eliminate suitable spawning substrate for salmon, steelhead and trout.

Elimination of multistoried vegetation along streambanks increases water temperature and reduces the supply of invertebrates used as a food source for fish.

The only potential for these impacts would be from aerial sprays in big sage and forest habitats. Other methods of control avoid riparian zones; and other habitats proposed for treatment do not contain significant fisheries values. These impacts could occur only under Alternative 1, and could be essentially eliminated through the use of buffer zones.

The possibility exists for herbicides to enter streams through either accidental direct application, drift, or movement of chemical residues from upland areas. As discussed in the Water Resources section, no significant amount of herbicide is expected to reach streams due to standard operating procedures and the mitigations which result from site-specific EAs before any applications. If chemicals are introduced to streams any exposure to fish would likely be of very short duration. Because of this short exposure and the proposed application rates, herbicides are not expected to significantly affect fish or their habitat under any alternative. For a detailed discussion of herbicide risks to aquatic organisms see Appendix L which relates possible doses to documented toxic effects on aquatic organisms. Only under highly unlikely assumptions related to aerial application would any significant risk to aquatic organisms and fish occur. Incorporation of buffer zones would eliminate any adverse impacts from applying picloram and herbicides applied aerially.

THREATENED OR ENDANGERED ANIMALS

Threatened or endangered species receive special attention under the provisions of the Endangered Species Act of 1973, as amended, and BLM policies and guidelines as outlined in Chapter 2. Known nest and roost sites of listed species are avoided or special precautions taken to ensure their protection. Formal consultations with the U.S. Fish and Wildlife Service, under Section 7 of the Endangered Species Act, are initiated for any action that "may affect" a listed species or its critical habitat. No adverse impacts to threatened or endangered species are anticipated under any of the alternatives.

WILDLIFE SUMMARY

Impacts on wildlife resulting from vegetation management would be mixed. Big game, upland game and nongame populations and diversity would benefit in some areas (chaparral, desert riparian, big sage, and forest) as a result of opening up dense brush fields, increasing edge effect and increasing vegetation and structural diversity. In other areas (big sage and forest), localized reductions in food supply and cover would negatively affect game and nongame species. As shown in Appendix L there are no likely toxic effects to wildlife from herbicide use.

In relation to the 14 million acres of wildlife habitat on public land in California and northwestern Nevada, these impacts are insignificant. Alternative 1 affects 0.07 percent of the EIS area's wildlife habitat annually. Approximately one-third of this would be in small tracts less than 40 acres in size. Only 0.04 percent would be affected annually under Alternative 2, all of this in small tracts. The impacts on wildlife under Alternative 3 would occur on 0.03 percent of the habitat.

Overall wildlife populations and species diversity within the EIS area would not change under any of the alternatives.

Table 3-2

Impacts on Wildlife by Alternative[1]

Impacts	Alt. 1	Alt. 2	Alt. 3
Pos. and Neg. (big sage and forest)	4,800 ac.	1,950 ac.	1,550 ac.
Positive (desert riparian & chaparral)	3,300 ac.	1,600 ac.	1,700 ac.
No Effect (woodland savannah, grassland, desert woodland)	1,700 ac.	1,700 ac.	1,300 ac.

[1] Excludes prescribed burns which total 26,000 acres under all three alternatives.

IMPACTS TO LIVESTOCK AND WILD HORSES

Impacts to livestock and wild horses could occur indirectly from exposure to herbicides. Although not identified as an issue, impacts could also occur directly from ingestion of poisonous noxious weeds.

Chemical treatments are generally applied in a form or at such low rates that they do not affect livestock. Most major treatments under the proposed alternatives would be applied when livestock are not in the treated area but spot treatments for control of noxious weeds would be applied at any time, regardless of the presence of livestock. Animals consuming forage treated with certain herbicides (picloram, 2,4-D and dicamba) cannot be slaughtered for food within the period of time specified on the herbicide label. Dairy animals should not be grazed on areas treated with certain herbicides (picloram, 2,4-D, and dicamba) for the length of time specified on the label.

Alternative 1 would yield the most profound positive impact by providing the largest increase in desirable forage for livestock and wild horses. Positive impacts of Alternatives 2 and 3 would be similar to one another yielding less forage production than the Proposed Action. Aerial herbicide application in Alternative 1 would also kill some shrubs and trees which are used for shelter by livestock. Manual and mechanical control under Alternative 3 would often be ineffective at controlling competing vegetation.

IMPACTS ON CULTURAL RESOURCES

Mechanical and burning control measures could potentially disturb or destroy cultural resources on or near the ground surface. The potential for damage would vary with the amount of ground disturbance and burning under each alternative. Tilling weeds could damage artifacts and disrupt relative positions of cultural materials. Mixing organic matter in archeological sites could contaminate carbon 14 dating samples, making them unreliable for scientific analysis. Uncovering sites could increase the possibility of illegal artifact collecting. Burning for weed control could destroy combustible cultural materials and damage stone and ceramic artifacts. There would be lowest potential for damage to cultural resources under Alternative 1 and a slightly higher potential under Alternative 2 with highest potential under Alternative 3.

Cultural resource surveys, however, would precede management actions that could damage cultural resources (BLM Manual 8100, Cultural Resource Management). Under all alternatives, sites found during these surveys would be managed in accordance with the National Historic Preservation Act of 1966 (PL 89-665) and Executive Order 11593, or the California Programmatic Memorandum of Agreement per 36 CFR 800.

IMPACTS ON VISUAL RESOURCES AND RECREATION

Treatments such as tilling, burning, and applying herbicides cause visual impacts mainly by creating color contrasts between treated areas and surrounding vegetation. Tilling disrupts the land surface and exposes bare soils to view. In addition to causing color contrasts, applying herbicides reduces vegetation variety and can prevent the occurrence of seasonal changes (spring flower, fall color) within treated areas. Burning creates contrasting blackened areas and releases smoke, which temporarily impairs visibility. These short-term impacts, however, would be offset in the long term by the growth of desirable plants on the site.

Most vegetation control treatments would be applied in visual resource management (VRM) Class IV areas (see Glossary). Because these public lands are generally of low to moderate scenic quality, are low sensitivity areas seldom seen by most people, and are intermingled lands managed mainly for livestock grazing, visual and recreation impacts in VRM Class IV would be low under all alternatives. Impacts of herbicide residue on the health of public land visitors are discussed in Impacts on Human Health.

Designated BLM recreation sites that are treated with herbicides will have signs posted stating the chemical used, date of application, and a contact number for more information. Signs will remain in place for at least two weeks after spraying.

Alternative 3 (No Action/No Herbicides) would adversely affect recreation areas infested with noxious weeds by increasing the exposure of visitors to the stickers of thistles and poison oak. Visitor use could decline. Alternatives 1 and 2 would benefit recreation areas infested with noxious weeds by decreasing visitor exposure to detrimental effects.

IMPACTS ON WILDERNESS AND SPECIAL AREAS

The control of vegetation in wilderness and wilderness study areas (WSAs) under all Alternatives would control exotic weeds that would otherwise compete with native plants. Under Alternative 3 though, fewer acres would be treated and less effective noxious weed control might be expected. Under Alternative 3, and Alternative 2 to a lesser degree, there would be less likelihood for accidental sprayings of wilderness and wilderness study areas.

As with wilderness areas or WSAs, all weed control treatments applied on or near the following designated or proposed areas would incorporate features designed to avoid or mitigate impacts on important resources: research natural areas; outstanding natural areas; national wild, scenic, or recreation rivers; national scenic or recreation trails; state recreation trails; and areas of critical environmental concern. Impacts would be most likely under Alternative 1, which proposes aerial spraying, and nonexistent under Alternatives 2 and 3. Site-specific impacts to special areas will be addressed further in District or Resource Area environmental analysis that precedes vegetation management action.

IMPACTS ON ECONOMIC CONDITIONS

Economic results of implementing any of the alternatives would be insignificant when considered in relation to the overall economy of the EIS area. When considered locally though economic considerations become more significant.

Appendix E presents the estimated costs of implementing each of the alternatives. These costs show only a 9 percent difference in total cost of the alternatives and an 11 percent difference in average treatment cost per acre between alternatives. However if the cost of prescribed burns is not included (since proposed burns are constant) the difference in cost per acre by alternative increases to 98 percent. Average cost per acre of nonburning treatments would be: $68.41 - Alternative 1; $111.81 - Alternative 2; and $135.60 - Alternative 3. This comparison gives a realistic comparison of the basic cost of each alternative and what an additional acre of accomplishment under each alternative would cost.

An indirect cost of vegetation control would be the cost of lost opportunity to improve forage production, wildlife habitat, timber production, and other benefits on areas left untreated. Compared to Alternative 1 Alternatives 2 and 3 leave 4,550 and 5,250 acres respectively untreated. These shortfalls in control efforts will result in lost opportunity to improve or maintain forage and timber production and other benefits which would be increased by control efforts. While these benefits are not possible to completely quantify, the effect on revenues from sale of timber alone are estimated to be $51,400 less for Alternative 2 and $202,000 less for Alternative 3 than under Alternative 1.

While economic information on range improvements is not available at this time a site-specific evaluation (SageRam, BLM Manual Handbook H-1743-1) is required before range improvements can be undertaken. This evaluation examines the cost and benefit of each proposed project.

BLM would fund the costs of vegetation control for reforestation, range improvements and recreation maintenance. Costs for wildlife habitat improvement (tamarisk control, chaparral management) are funded by BLM, CDF&G and other contributors. Costs for noxious weed control are funded primarily by counties and the state, while private companies would fund vegetation control associated with right-of-way and lease maintenance. Because of these different funding sources the cost of vegetation control is spread among many sources.

The costs to implement any of the alternatives is small when compared to the total costs for similar actions statewide. Expenditures for herbicides by agricultural interests in the area are much greater than proposed in Alternatives 1 and 2. The California Department of Forestry and Fire Protection, USFS and private landowners spend much more for prescribed burns than BLM proposes. These factors all demonstrate the relative economic insignificance of BLM's vegetation control program on a statewide basis. However the program is very important when considered on a local or site-specific basis. Local individuals rely on both the continued productivity of public lands and on employment in vegetation control activities for their economic livelihood. These people often reside in areas where the local economy relies to a great degree on the expenditure of dollars for vegetation control and utilization of resources from the public lands, i.e., livestock forage, lumber industry, and recreational opportunities. There is often no other viable means of economic support in these communities.

In summary the proposed program would allow for economic productivity of the public lands with Alternative 1 providing the greatest return and Alternative 3 the least. This relationship would also be the same for impacts to localized rural economies. Besides providing the highest level of economic productivity Alternative 1 would have the lowest unit cost and Alternative 3 has the highest unit cost.

IMPACTS ON THE SOCIAL ENVIRONMENT

BLM's noxious vegetation control program would directly and indirectly affect social conditions and attitudes. Direct impacts would occur when senses of personal well-being or economic security are affected by BLM's decisions on the use or restriction of vegetation management practices. Indirect effects would occur as a result of economic outcomes of BLM policies and in response to gains or losses of recreational opportunities or access to subsistence activities. Examples of social effects deriving from economic impacts include people's reactions to changes in the availability of different kinds of jobs and their dependence on certain jobs. Whether direct or indirect, all of these impacts could affect lifestyles.

The economic impacts of the alternatives on the local economy are discussed in the preceding section of Chapter 3. The economic effect on individuals who gain or lose jobs would be essentially the same wherever they live. Social effects, however, would depend on whether the jobs gained or lost are concentrated or dispersed or in small or large communities. For example, the gain or loss of 100 jobs scattered around the larger cities in the EIS area would not have significant social effects. In contrast, the concentration of those 100 jobs in two small towns with a combined work force of 500 would significantly affect social conditions in these towns.

The social impacts of employment changes can be estimated, but data does not exist to allow the projection of where those impacts would occur.

Alternatives 1 and 2 would probably have beneficial social impacts on communities in the EIS area, and none of the alternatives is expected to have significant social impacts resulting from employment changes associated with increases or decreases in forage or timber productivity. The affected jobs would probably be mostly in the northern half of the EIS area.

Because of the controversy surrounding herbicide use, Alternatives 1 and 2 would have social effects specifically related to this issue. Alternatives 1 and 2 propose the use of herbicides and would be perceived as involving some harm by those opposed to herbicides. These impacts would be greatest under Alternative 1 and somewhat less under Alternative 2. Alternative 3 would be perceived as having the most adverse impacts by those who support the use of herbicides in vegetation management.

Many people believe that herbicides are safe to use and that risks associated with herbicide use are acceptable to themselves as individuals and to society. These people could perceive limitations on the use of herbicides as threatening to their jobs and lifestyles, and in some large sense to society as a whole. The threat they perceive to society is usually articulated as job losses forcing some to go on welfare.

On the other side of the herbicide controversy are others, particularly residents near areas to be sprayed, who perceive helicopter spraying as a threat because they associate helicopters with military activities or because they feel helpless to avoid exposure or to stop the spraying in case of unexpected drift or accidental overflight of nontarget areas. These people would be adversely affected by Alternative 1, which proposes helicopter spraying of herbicides.

Another category of social effects related to the use of herbicides includes fears and anxieties about human health and personal safety. These concerns would be related to the amount of herbicides used and would thus be greatest under Alternative 1 and less under Alternative 2. For those concerned about this issue, Alternative 3 would have beneficial impacts.

IMPACTS ON HUMAN HEALTH

PRESCRIBED BURNING

Smoke from burning is not expected to significantly affect human health under any alternative. Levels of suspended particulates (a suspected factor in some health problems) are expected to be well below the 150 micrograms per cubic meter (ug/m^3) public welfare standard and the 260 ug/m^3 public health standard published by EPA. Effects of smoke would be minimized by complying with the required burn permits which include coordination with weather forecasts to determine burn or no burning days.

Burning of vegetation previously sprayed with herbicides would not be done for several months to one year after the spraying. This would allow the chemicals adequate time to be degraded to nonhazardous metabolites thus resulting in no expected impacts to humans from combustion.

Workers on burn areas would be exposed to potential injury from the manual treatments they would apply and the conditions under which they would work (see discussion under Manual and Mechanical Treatments below). Workers who manually ignite burn areas would be exposed to burning materials, which could cause physical injuries.

The probability of workers on burn areas being injured would be the same under all Alternatives.

Public safety would not be affected by any method of igniting burn areas. Most burning would occur where the public either would not be present or would be highly visible to those doing the burning. Further, those on or near a burning area would be well aware of impending activities because several hours of active preparation are required before ignition begins. Safety measures normally taken to protect firefighters participating in prescribed burning would also protect the public.

A report to BLM on impacts of smoke from burning is found as Appendix G. This report basically studies the polyaromatic hydrocarbons (PAH) found in smoke and is the first step in assessing the potential environmental health risks associated with smoke derived from burning forest and range residues. Products of combustion include several discrete groups. There are a great number of low-molecular hydrocarbons which are relatively innocuous, nitrogen oxides may have some environmental effects but may not represent a primary health hazard, and then the PAH which are large compounds of multiple benzene rings. The analysis in Appendix G concentrates on these compounds as the most likely candidates for human health risk, primarily cancer. Based on assumptions concerning exposure over 70 continuous years to benzo(a) pyrene (BAP) (one PAH) a conservative probability of 3×10^{-3} for contracting cancer is predicted. A more realistic risk of cancer based on research measurements of all PAHs in smoke is 8×10^{-8}. It is questionable if the rather severe exposure sequence assumed for prescribed fire would ever occur. However it should be used for analysis until additional specific data causes it to be changed.

MECHANICAL TREATMENTS

Operators of machinery (tractor operators) could be injured by losing control of equipment on steep terrain or by coming into contact with flying debris and brush. Such hazards would be most likely under Alternative 3 and least likely under Alternative 1.

MANUAL TREATMENTS

Under Alternative 1, and particularly Alternatives 2 and 3, some hand pulling would be needed. Hand pulling exposes workers to the hazards of physical contact with irritant weeds that cause blisters, inflammation, and dermatitis. Sensitive individuals can react severely to the pollens and the close contact of hand pulling could cause major discomfort or health risk. A severe hazard of hand pulling is the high potential for poisonous snake bite. The remoteness of many treatment areas and the time needed to gain medical attention could make a poisonous snake's bite a serious health concern.

There would also be some hazard to operators of chainsaws for manual treatments. The level of hazard would be highest under Alternative 3 and lowest for both Alternatives 1 and 2.

CHEMICAL TREATMENTS

The analysis of human health risks from the use of the 16 herbicides in BLM's California vegetation management program was accomplished using the methodology of risk assessment widely accepted by the scientific community. In essence, the risk assessment compares herbicide doses that people may get from applying the herbicides or from being near an application site with doses shown likely to be safe to humans in long-term studies on laboratory test animals. For the herbicides that could possibly cause cancer, the risk of cancer over a person's lifetime was based on animal studies that related the chances of developing tumors to increasing herbicide doses. The details of the risk assessment are presented in Appendix H.

The conservative approach used in this risk assessment tended to exaggerate the estimated risks to human health from herbicide use. A number of assumptions about the proposed herbicide spraying operations tended to overestimate the doses workers and the public would be likely to receive. The way herbicide toxicity information was used to judge risks based on effects seen in the most sensitive laboratory test animals tended to make that part of the risk assessment conservative. This conservatism, both in estimating exposures and in setting toxicity levels, when combined to judge risks, led to an exaggeration of the real risks of the vegetation management program to err on the side of protecting human health.

Risk Assessment Conclusions

The risk assessment indicated that risks to the public of systemic or reproductive toxic effects from routine spraying operations are very low for all 16 of the proposed herbicides. The ratio between the safe lab animal doses and the estimated public exposures was 150 to 1 or greater, giving a large margin-of-safety. The possibility of toxic effects increases when the public are assumed to be exposed as a result of accidents, however, the real risks are also low here because of the extreme unlikelihood of an accident directly exposing any member of the public.

Risks to workers are higher than those of the public both in routine operations and as a result of accidents. Workers have a far greater chance of being exposed than any member of the public and are likely to get higher doses than the public when they are exposed.

Cancer risks for the proposed herbicides are low. Available laboratory evidence indicates that dalapon, dicamba, diuron, fosamine, hexazinone, simazine, tebuthiuron, and triclopyr do not cause cancer. A cancer risk analysis was conducted for the eight herbicides that showed positive or questionable responses in laboratory cancer studies. The analysis was based on up to 30 estimated realistic and worst case lifetime exposures to the public assuming single and multiple exposure sources. Results showed that for aerial applications the worst case cancer risk for 30 exposures from multiple sources is less than 3 in 10,000 for atrazine. For 2,4-D the worst case cancer risks are less than 2 in 100,000. The risk for picloram is never greater than 7 in 10 million. Cancer risks to workers who are exposed at higher levels more frequently are higher than the risks to the public.

There appears to be little risk that the herbicides would cause heritable genetic mutations. Exposures of members of the public should be low if any occur at all. Available evidence indicates that bromacil, dicamba, fosamine, glyphosate, and hexazinone are not mutagenic. They tested negative in the majority of mutagenicity assays reported and were not positive in available cancer tests. No mutagenicity studies were reported for dalapon or diuron but they were not shown positive in cancer tests. There is conflicting evidence of mutagenicity for amitrole, asulam, atrazine, 2,4-D, 2,4-DP, picloram, simazine, tebuthiuron, and triclopyr due to positive results in a number of mutagenicity assays and in at least one cancer study. However, there is no strong evidence to indicate that any of these latter herbicides would be likely to cause heritable mutations at the levels of exposure that may occur in BLM's program.

Synergistic effects are not likely to occur since synergism rarely occurs with chemical mixtures. The herbicide mixtures that may be used in the BLM's program have not shown synergistic effects in humans that have used them in other applications although there is some evidence that mixtures of 2,4-D and picloram may cause skin irritation.

Cumulative effects are not likely to occur because none of the herbicides is persistent in the environment or in the human body, no member of the public is likely to be chronically exposed in BLM's program, and no one is likely to receive simultaneous exposures from these same herbicides used in any other programs in California.

The structure of the risk assessment, the ways in which risks tended to be exaggerated, and a summary of the risk assessment results are described below.

Risk Assessment Structure

The risk assessment consisted of three steps: a hazard analysis, an exposure analysis, and a risk analysis.

The hazard presented by a chemical pesticide is its inherent toxicity or poisonous quality that may cause brief, reversible effects such as nasal irritation or nausea in humans who receive small amounts, or that in the extreme case, may cause death. All chemicals are injurious to health at some level of intake; even commonly consumed items such as aspirin, table salt, and sugar. As shown in Table H-2, the herbicides examined in this risk assessment in general are less acutely toxic at a given dose than insecticides, fumigants, and many other common chemicals to lab test animals.

Exposure is the amount of pesticide in a person's immediate surroundings (in the air, on their skin, in their drinking water). The amount that enters their body--that is ingested, inhaled, or that passes through their skin, during a specified time period--is their dose. A person's dose is usually expressed in milligrams of chemical per kilogram of body weight (mg/kg).

Risk in the case of chemical pesticides is the possibility or likelihood, under a specified set of circumstances leading to a given exposure, that a person may experience any of the range of toxic effects described above. In BLM's program, it is the possibility of experiencing toxic effects because of an exposure to one of the 16 alternative herbicides.

The Hazard Analysis

In the hazard analysis, a review was made of toxicity studies in open literature and of publicly available summaries of proprietary data to determine the toxic properties of each herbicide. The hazard analysis included a review of relevant laboratory toxicity studies on acute (single dose), subchronic (short term dosing), and chronic (long-term or lifetime dosing) effects caused by exposures via dermal, inhalation, and ingestion routes. The hazard analysis results are summarized in Table H-24.

The oral LD_{50} in rats (the single dose that kills half the animals tested) is the generally acknowledged benchmark of the acute toxicity of a chemical. It is usually found at test doses that far exceed any that are liable to occur in the handling and use of the chemical by humans. The rat oral LD_{50}s for the 16 BLM herbicides are listed in Table H-24.

Long term animal studies (subchronic and chronic studies), lasting 90 days to 2 years for most tests, are used to establish safe levels for humans. The safe lab animal level is the no-observed-effect level (NOEL) in a long term study--the dose that a test animal can receive every day without ill effects. Additional safety factors are used to extrapolate from the safe animal dose to a safe human dose. The generally recognized safety factor is 100 based on a factor of 10 to move from animals to humans and a factor of 10 to account for variable responses in humans. Table H-24 lists systemic NOELs for each herbicide. A discussion of the animal studies and the choice of NOELs is given in the Appendix H risk assessment.

Reproductive toxicity studies determine whether a chemical will affect the fetus or mother during gestation and cause abortions or malformed offspring (teratogenesis). A separate NOEL for these effects has been set for the 16 BLM herbicides. These reproductive NOELs are listed in Table H-24.

For the herbicides that had positive cancer tests, a cancer potency value that relates the probability of tumor formation to increasing lifetime doses is the parameter of concern. Those values are listed in Table H-24 for amitrole, asulam, atrazine, bromacil, 2,4-D, 2,4-DP, glyphosate, and picloram.

No comparable value can be used to estimate the likelihood of a human developing heritable mutations so the risk of mutagenicity is considered only in a qualitative manner based on the results of mutagenicity assays and cancer tests.

The Exposure Analysis

Two human populations, workers and the general public, are at risk from herbicide applications. Worker personnel such as mixer/loaders and backpack sprayers are directly involved in treatment operations. Members of the public, including public land visitors and nearby residents, may be exposed to herbicide drift, to vegetation with herbicide residues, or to an accidental spraying. They could also eat food or drink water with herbicide residues.

The exposure analysis determined how high the exposures and resultant doses of workers and the public are likely to be from routine operations and possible accidents under BLM's proposed program. No analysis could consider all the possible circumstances of herbicide spraying, so scenarios were used that were simplified descriptions of spraying operations and potential routes of human exposure.

Four scenarios (helicopter, truck, backpack, and hand application) were used to estimate realistic worker doses in routine operations (routine-realistic scenarios). Four additional scenarios with the same methods of application were used to estimate the highest doses workers might get in routine operations (routine-worst case scenarios). The worker dose estimates were derived from actual worker field study data of 2,4-D doses found by urine analysis. These studies showed that inhalation exposure was a neglible contributor to a worker's total dose so no separate estimate of worker inhalation doses was made. Scenario dose estimates were adjusted for hours worked, application rate, and the different skin penetration rates of the other herbicides.

Three of the four routine-realistic scenarios (helicopter, truck, and backpack spraying) were used to estimate public doses. The same three routine-worst case scenarios were used to estimate the highest likely public doses. Because no studies of public exposure comparable to the worker studies were available, the public's doses were estimated by a mathematical accounting (modeling) of the movement and fate of each herbicide in the area of spraying to estimate exposure levels on their skin, on their food, and in their drinking water. As in the case of workers, inhalation exposures of the public were considered neglible and were not estimated.

Dermal doses from the smaller herbicide spray droplets drifting offsite and depositing on a person's skin or from brushing up against vegetation with drift residues were estimated. Doses to a person drinking water with herbicide residues and eating berries, deer meat, game bird meat, garden vegetables, and fish containing herbicide residues were also calculated.

Cumulative doses to five "example" members of the public--hikers, berry pickers, hunters, fishermen, and nearby residents--that receive doses simultaneously through several exposure routes were calculated.

Scenarios were also used to estimate worker and public doses from accidents. Worker accidents included a spill of concentrate or spray mix on their skin and a direct spraying. Public accidents included a direct spraying and drinking water from a pond or reservoir contaminated by a spill from a truck or helicopter.

The Risk Analysis

The risk analysis was conducted after the worker and public exposures were estimated. The scenario-based estimates of doses to workers and the public were compared with the toxicity levels detailed in the hazard analysis. These comparisons were used to determine the risk to humans under the specified circumstances of exposure.

For threshold effects, the doses were compared to no-observed-effect-levels (NOELs) determined in the most sensitive animal test species. A margin of safety (MOS), the animal NOEL divided by the smaller estimated human dose, was computed to relate the doses and effects seen in animals to estimated doses and possible effects in humans. For example, an animal NOEL of 20 mg/kg divided by an estimated human dose of 0.2 mg/kg gives an MOS of 100. A margin-of-safety of 100 is comparable to the 100-fold safety factor described in the Hazard Analysis section as being generally recognized as safe for humans. The larger the margin of safety (the smaller the estimated human dose compared to the animal NOEL), the lower the risk to human health.

When an estimated dose exceeded a NOEL the dose was divided by the NOEL and a minus sign was attached. The result was not a margin of safety but simply a negative ratio. A negative ratio did not necessarily lead to the conclusion that there would be human toxic effects since all of the NOELs used in the risk analysis are based on no-effect levels in long-term animal studies and the estimated doses are not likely to occur often. This applies particularly to doses that are not likely to occur more than once, such as those to the public. Doses that greatly exceeded the NOEL were also compared to the herbicide's acute LD_{50} to evaluate the risk of fatal effects.

Systemic effects were evaluated based on the lowest systemic NOEL found in a 2-year feeding study of dogs, rats, or mice (or from a subchronic study if that NOEL was lower). Reproductive effects were evaluated based on the lowest maternal, fetotoxic, or teratogenic NOEL found in a 3-generation reproductive study or in a teratology study.

A worst case analysis of cancer risk was conducted for the herbicides considered to be suspect human carcinogens--amitrole, asulam, atrazine, bromacil 2,4-D, 2,4-DP, glyphosate, and picloram--by comparing estimates of lifetime dose with cancer potency estimates derived in the Hazard Analysis. A worst case analysis was also conducted for those herbicides that had positive mutagenicity tests or those for which no data were available. The risk of these herbicides causing mutations was judged on a qualitative rather than a quantitative basis, with a statement of the probable risk based on the available evidence of mutagenicity and carcinogenicity.

Uncertainty Factors and the Exaggeration of Risks

A number of factors contributed to the uncertainty in the process of judging risks to human health in the vegetation management program, and in each of these cases, a series of conservative assumptions or factors were used that tended to exaggerate the risks.

First, the safe herbicide doses established in the laboratory are the result of tests on laboratory animals, particularly rats and mice, where doses produce no observed effects. To allow for the uncertainty in extrapolating from NOELs in lab animals to safe levels for humans, the margin-of-safety approach was used as described previously.

A second area of uncertainty is in judging the risk to human health of doses that may be received once or perhaps a few times in a person's life (accidental worker doses and all doses to the public fall in this category) by comparing those human doses to levels of the chemical that produced no ill effects in laboratory animals even though the animals received the doses daily in long term studies. The risk assessment uses the MOS approach discussed above in comparing one-time human doses to lifetime animal doses in all of these cases even though this leads to an exaggeration of the risks.

A different approach was required in assessing the risks to humans of chemicals that may cause cancer. Because the exact mechanisms and effective (threshold) doses that cause cancer are not known to scientists, chemicals that could cause cancer were assumed to have no threshold of effects and no margin of safety comparable to that used to judge the risks of systemic or reproductive effects. It was assumed that there was some risk of cancer no matter how small the dose.

Where there was evidence from a long term study that a herbicide could cause an increase in tumor formation with increasing doses, a cancer potency value was taken from the lab animal study and adjusted for the differences in metabolism and lifetime duration between the lab animals and humans. Data of this kind existed for amitrole, asulam, atrazine, bramacil, 2,4-D, 2,4-DP, glyphosate, and picloram. The cancer potency value multiplied by an estimated human lifetime dose provides an estimate of human cancer risk.

A number of factors in the cancer risk analysis tended to exaggerate risks. The cancer potency value used to compute the human lifetime risk was derived from tumor data on the test species and sex showing the highest rate of tumor formation with increasing dose. The mathematical model used to extrapolate from the lab tumor data to likely human risk was the most conservative of the models currently in use by the scientific community. In addition, the upper limit of the 95 percent confidence interval around this risk estimator was used instead of the average potency value.

Uncertainty was also involved in the estimation of the human doses liable to occur in herbicide use. The risk assessment overestimated doses to err on the side of safety. In reality, workers are likely to receive some low level doses because they work with the chemicals routinely. However, standard safety practices and the use of protective clothing should reduce their actual dose levels below those estimated in this analysis. The same is true of the doses from any spraying or spill accidents that might occur, since the normal procedure would be to wash immediately.

Should a member of the public actually receive a dose, it is unlikely to be as high a dose as estimated in this risk assessment. Normal safety practice and the remoteness of most treated areas limit the possibility of the public receiving any dose at all. Several aspects of the analysis tend to exaggerate the public doses. No herbicide degradation is assumed to occur and the public is not assumed to wash themselves or their food items after a spraying or to cook fish and game meat before they are consumed. They are assumed to consume water that has received herbicide from drift or from a spill immediately after the event. Thus, the way exposures to both workers and the public are estimated in this risk assessment and the way the toxicity information is used both tend to exaggerate the real risks, to err on the side of protecting human health.

RISKS OF SYSTEMIC AND REPRODUCTIVE EFFECTS

Risks to the Public from Routine Operations

Table H-25 summarizes the margin-of-safety results for the public for the 16 herbicides under both the routine-realistic and routine-worst case exposure scenarios.

Public Risks from Routine-Realistic Doses

Table H-25 shows that there are large margins of safety (greater than 150) for every category of public exposure--even cumulative exposures--under the routine-realistic scenario for all 16 proposed herbicides, except for amitrole which has the lowest MOS of 32. Because no member of the public should be exposed the majority of the time, these margins of safety mean that the public should suffer no adverse effects. This is true for all individuals including pregnant women and the vast majority of sensitive individuals.

Exposure routes presenting the lowest risk are direct dermal exposure to spray drift and eating animals or fish that have drift residues. The representative members of the public at greatest risk from multiple exposures are the nearby resident and the berrypicker. Persons at least risk are the hunter, hiker, and fisherman. These relationships hold for all 16 herbicides.

Although the routine-realistic scenarios represent what can happen under routine operations, the probability of people receiving the doses estimated here is low because there are no residents, hikers, fishermen, or berrypickers in the vicinity of the vast majority of treatment units and, as described previously, these scenarios use a number of conservative assumptions that tend to overestimate the size of the doses.

Public Risk from Routine-Worst Case Doses

The routine-worst case scenarios estimate the highest likely public exposure levels from routine herbicide applications in the Pacific Northwest. The events leading to the exposures described in Table H-25 have a very low probability of occurring. It is unlikely that anyone would receive a dose as high as those estimated here. Under these extreme assumptions, risk to individuals is very low except for people who receive multiple exposures from a 400-acre fixed wing application.

Table H-25 indicates that all margins of safety under the backpack and right-of-way routine-worst case scenarios are greater than 100 except for amitrole and diuron.

Margins of safety calculated for combined routes of exposure to 2,4-D and triclopyr range from 10 to 50 in the worst case aerial application. Chronic doses of 2,4-D, as predicted by this analysis, could affect the peripheral nervous system but, in most cases, these effects are reversible. People who chronically receive triclopyr doses as high as those predicted here could experience kidney problems. Because the margins of safety were computed by comparing acute exposures with chronic no-effect levels, the risk of occurrence of these effects can be considered relatively low.

The margins of safety computed in the worst case 400-acre aerial spraying scenario indicate that sensitive individuals could suffer some acute toxic effects from the predicted exposures to atrazine, 2,4-D, and triclopyr. For atrazine, all margins of safety less than 100 are greater than 50 except for a berrypicker who is dermally exposed for 4 hours, eats 0.9 pounds of berries and drinks a liter of water contaminated at the highest possible level. This person could experience some systemic effects. However, that is unlikely because these one-time doses are all more than 10,000 times lower than the LD_{50}. It should be noted that the systemic NOEL for atrazine is based on weight loss in dogs. Therefore, sensitive individuals could become ill and possibly experience stomach problems.

The probability of someone receiving a dose as high as those predicted under the routine-worst case scenarios is negligible because these scenarios assume that a number of unlikely events occur simultaneously. The probability of someone receiving a dose as high as is predicted here is on the order of 1 in 1 million. The Forest Service's experiences in these operations indicate that the probability of the scenario events occurring simultaneously is even lower.

Public Risk from Accidental Doses

Table H-26 summarizes the risk to the public from direct exposure to aerial applications or from eating food or drinking water that has been directly hit at the highest application rate. The relatively low margins of safety for amitrole, atrazine, bromacil, 2,4-D, diuron, and triclopyr indicate that people exposed to a direct aerial application or exposed to items that received the highest application rate could experience some toxic effects. The extent of effects would depend upon their duration of exposure and any precautionary measures that were taken. For example, if people gathered a bushel of berries from a spray area and did not wash them but froze them and then ate them every day for a month, they would probably feel ill. However, if people bathed after being in the forest or washed food items before eating them, the doses would drop (and thus increase the margins of safety) substantially.

It must be emphasized that these are one-time, rather than repeat or chronic, exposures and that the comparison of these doses with the acute LD_{50}s shows that no one is at risk of fatal effects. Complete margins of safety computed for each chemical and application under the accidental worst-case scenarios are presented in the Appendix H risk assessment.

Worker Risk from Routine-Realistic Doses

In the routine-realistic scenarios, all categories of workers applying asulam or picloram have MOSs greater than 100. This indicates that even workers chronically exposed to these herbicides should suffer no ill effects. As shown in Appendix H Tables H-27 to 28, backpack sprayers are at greatest risk based on comparisons of estimated doses with systemic and reproductive NOELs. Except for asulam and picloram, all backpack sprayers had MOSs less than 100. Doses of atrazine, 2,4-D, and triclopyr to backpack sprayers gave MOSs less than 10; and in the case of diuron, the dose exceeds the NOEL. This means that unprotected sensitive workers may experience some toxic effects from routinely applying these herbicides in certain situations. The doses and margins of safety are based on 6 hours per day of exposure. Any reduction in the time of exposure would reduce the dose and increase the margin of safety proportionately.

Diuron appears to be the herbicide presenting the greatest risk from repeated exposures to other types of workers. Backpack sprayers using diuron in the routine realistic scenario receive a dose that is greater than the systemic NOEL. Diuron systemic MOSs for hack-and-squirt applicators are less than 10 in the routine realistic case.

2,4-D and amitrole present the next highest long-term risk. Backpack sprayers using amitrole and 2,4-D in the routine-realistic scenarios receive doses that have systemic margins of safety less than 10. Other workers using 2,4-D and amitrole also have MOSs less than 50.

Triclopyr has at least 4 margins of safety for workers (including those for backpack sprayers) that are less than 100.

Protective clothing can substantially reduce worker exposure by 27 to 99 percent as shown in a number of relevant field studies. Margins of safety calculated for routine-realistic and routine-worst case exposure to workers wearing protective clothing are presented in the Appendix H Tables H-27 and H-28.

Worker Risk from Routine-Worst Case Doses

Table H-29 and 30 show backpack sprayers using amitrole, diuron, 2,4-D, or triclopyr in the routine-worst case scenario receive doses that exceed their respective systemic NOELs. In addition, doses calculated for truck applicators and hack-and-squirt applicators using diuron exceed the systemic NOEL. Margins of safety for the reproductive NOELs are much higher. No applicator dose exceeds the reproductive NOEL for any herbicide in any situation.

All categories of workers, except the aerial supervisor and observer, have margins of safety less than 10 for at least one of the herbicides. Picloram and asulam are the only herbicides that always have margins of safety greater than 20 for all categories of workers.

The vast majority of the time workers will be receiving doses less than those predicted in the routine-worst case scenario. The probability of workers receiving repeated daily doses as high as predicted here is less than 1 in 1,000.

Risk to Workers from Spilling Concentrate or Spray Mix on Their Skin

The doses estimated here are based on dermal penetration levels derived in studies over many days; these chemicals do not penetrate the skin immediately but over a considerable period of time. Workers would have to ignore their own safety and not wash the chemical off to receive doses as high as predicted in these accidents.

For workers who spill a pint of concentrate or spray mix on their skin there is some certainty that, with the exception of picloram, they would experience acute toxic effects if they did not wash it off. The modeling used in the analysis assumed that a certain percentage of the herbicide penetrates the skin instantaneously. In reality, the penetration through skin occurs over a period of many hours. In the case of a spill of a pint of concentrate, many of the doses approach the LD_{50}. This represents a clear risk of severe toxic effects if the herbicide is not washed off. There is some possibility that the damage caused by such a large acute dose could cause long-term damage to vital organs. There have also been rare instances in which limited exposure to 2,4-D has been reported to cause permanent nerve damage. The dose and the risk is much greater for spills of concentrate than it is for the spray mix but, again, it is highly unlikely that a worker would allow the chemical to penetrate his skin for any period of time. The Appendix H Table H-31 risk assessment presents the complete listing of MOSs and comparisons to LD_{50}s for each herbicide.

Risk to Workers and the Public from Large Spill Accidents

Table H-32 summarizes the margins-of-safety for people drinking one liter of water contaminated by a large spill of herbicide from a helicopter or truck. Most drinking water reservoirs would dilute the herbicide below no-observable-effect levels in a relatively short period of time. BLM, in addition to EPA and the states, has procedures to minimize the risk to human health should a spill of this magnitude occur in or on the vicinity of a drinking water reservoir. When the spill has been diluted the risk to members of the public should be much lower.

Spills into a small, stagnant pond would result in significantly higher doses and, in the event of a truck spill of 2,000 gallons would constitute a risk of chronic effects if members of the public continued to drink from it. Spill accidents occur only very rarely; most recorded spills have involved 30 gallons or less of chemical; so the chances of this type of chronic exposure are negligible. BLM has detailed spill prevention and clean up procedures that would attempt to ensure that no member of the public was chronically exposed to a spill of this magnitude.

CANCER RISK

Cancer risks for atrazine, asulam, 2,4-D, glyphosate, and picloram were calculated based on a variety of conservative assumptions that are likely to overestimate the risks. These assumptions outlined previously are described in detail in the Appendix H risk assessment.

Cancer risk for the general public was calculated for a single exposure, and for 30 exposures over a lifetime. The approximate cancer risks to the public for the aerial routine-realistic scenario are shown in Table H-34. (See Attachment C for the presentation of cancer risks to the public for the other routine exposure scenarios.) The risk of cancer due to any of the routes of exposure in the typical aerial spraying scenario is less than 1 in 10 million risk when using atrazine. For 2,4-D, and picloram, none of the routes of exposure in any scenario results in a cancer risk greater than about 1 in 100 million, per exposure.

Cancer risk to workers has been calculated for an expected case assuming 5 years of employment in herbicide application, and an average number of days of spraying per year. The average number of exposures per lifetime was estimated to range from 30 to 70. The risk has been calculated in the extreme case assuming 30 years of employment and a total of 288 to 480 exposures. It is very unlikely that a worker would apply herbicides on the number of days assumed in the worst case. (Cancer risk to workers for the accidental-worst case scenario is shown in Table H-36.) The risks for each herbicide were calculated assuming that only that herbicide was used. The highest risks for workers involve atrazine and 2,4-DP use. The lifetime cancer risk to a backpack sprayer using only atrazine or 2,4-DP is about 1 in 10,000 in the expected case. In the worst case the risk is greater than 1 in 1,000. The risk is much less for the other chemicals. The highest risk for 2,4-D is about 1 in 100,000 for backpack spraying in the expected case, and in the extreme case the greatest risk is about 1 in 10,000. Workers using asulam in the extreme case have a lifetime cancer risk of less than 1 in 100,000 in all worker categories. The risk of picloram or glyphosate use is even less for all worker categories. The risks in the expected case never exceed 1 in 10 million.

Cancer risks calculated for exposures due to accidental spraying are shown in C-165. Among the chemicals, the greatest risk for a single exposure is about 8 in 100,000 exposure to amitrole. Multiple incidents could be expected to result in cumulative risks. Cancer risks calculated for spill situations are also shown in C-166.

The greatest risks are for spills of herbicide concentrate directly onto clothing and skin. Workers are at the greatest risk for this type of accident. The tabled values assume that most of a person's skin has been contacted by the solution, and cleanup does not occur for several hours. This is certainly contrary to standard practice. A spill of 2,4-D concentrate onto a person gives a risk of about 1 in 10,000, and a spill of spray mixture gives a lesser risk of about 5 in 100,000. The risk of cancer due to spills of asulam is about 5 in 100,000 for the concentrate and 4 in 1 million for the spray mixture. A spill of picloram or glyphosate concentrate gives a risk of 2 in 1 million or less. Cancer risks arising from even major spills into drinking water supplies are similar. A 100-gallon helicopter load of 2,4-D dumped into a 1-acre pond would lead to a risk of cancer of not more than 8 in 100 million for a person drinking a liter of the water. If a 1,000-gallon tank truck of mixture were spilled into a small pond, the risk for 2,4-D would be less than 2 in 1 million.

RISK OF HERITABLE MUTATIONS

No human studies are available that associate any of the herbicides with heritable mutations. No risk assessments that quantify the probability of mutations are available in the literature or from EPA. Laboratory studies constitute the best available information on mutagenic potential. Results of the mutagenicity assays conducted on the 16 herbicides are summarized in Table H-5.

Asulam and glyphosate tested negative for mutagenicity in all assays conducted, and thus can be considered to pose no mutagenic risk.

Amitrole, bromacil, fosamine, hexazinone, simazine, and triclopyr were nonmutagenic in the great majority of assays conducted and were nononcogenic in all of the carcinogenicity tests performed; therefore, it can be assumed that their mutagenic risk is slight to negligible. Dicamba was nonmutagenic in most of the assays performed and no oncogenicity was found in several long-term studies. EPA (1985d) has classified the chronic studies as "inadequate to evaluate the oncogenic potential of dicamba." Due to the bulk of negative results, dicamba can be considered as a mutagen in the worst case analysis but the mutagenic hazard would be extremely limited.

No validated mutagenicity studies have been conducted for dalapon or diuron. The worst case assumption is that all of these chemicals are mutagenic. The probability dalapon or diuron causes heritable mutations is low because they have not been shown to cause cancer in any long term studies.

The negative oncogenic studies for diuron were classified by EPA (1985d) as inadequate to determine carcinogenic potenital to mammalian organisms. The lack of positive results in any mutagenic or oncogenic tests with diuron suggests that diuron would present only minute risk to humans as a mutagen.

Atrazine tested positive for mutagenicity in 15 of 33 assays. The worst case assumption is that atrazine is mutagenic. However, many of the positive results were achieved through tests that may not be relevant to evaluating mutagenic risk in humans. Some positive results in rodents were also achieved, but these in vivo responses were only observed at levels greater than 1,500 mg/kg body weight. These are exceptionally high levels and suggest that the degree of germ cell hazard from low levels of atrazine would be minimal at best.

For picloram, 2,4-D, 2,4-DP and tebuthiuron there have been only a few studies performed and these have indicated both positive and negative mutagenic potential. A number of comprehensive reviews of the 2,4-D mutagenic data have indicated that it does not pose significant risk of human gene mutations (USDA, 1984). 2,4-D has been shown to be nononcogenic in the two carcinogenicity studies that have been conducted. Based on a worst case estimate, the risk of heritable mutations from these chemicals would be no greater than the estimates of cancer risk.

SYNERGISTIC AND CUMULATIVE EFFECTS

Synergistic Effects

Synergistic effects of herbicides are those that occur when the combined effect of the two chemicals is much greater than the sum of the effects of each given alone. Based on the limited amount of data available on pesticide combinations, it is possible but very unlikely that synergistic effects could occur as a result of exposure to two or more of the herbicides.

Simultaneous exposure to more than one chemical is likely in cases where those chemicals are combined in a single spray mixture. Although the great majority of vegetation control projects in the Region involve only a single herbicide, a number of acres are treated with mixtures of herbicides. However, the only herbicide mixtures used are combinations that have been approved for use by the Environmental Protection Agency.

The toxic effects of many of the possible herbicide combinations have not been studied. The first priority in toxicity testing is to study the effects of the herbicides individually, and this type of information is not yet sufficient in some cases. Moreover, the combinations that could be studied are too numerous to be examined. The combinations of interest include not only combinations of 2 or more of the 16 herbicides, but also combinations of the herbicides with other chemicals, such as insecticides, that exist in the environment.

Based on a review of acute oral LD_{50}s for mixtures of 2 or more of the 16 herbicides, no synergistic effects were found. In no case is the mixture of two herbicides more acutely toxic than any of the constituents. For example, a mixture of 2,4-D and dicamba resulted in a NOEL of 1,847 mg/kg, with lower acute LD_{50} values reported for the technical grade of both mixture constituents (EPA, 1984e). Rat inhalation studies of formulations containing 2,4-D and picloram did not result in toxic effects (EPA, 1984q) although the combination of 2,4-D and picloram appeared to produce skin sensitization, while neither alone produces this effect. (EPA, 1984q).

It is unlikely that synergistic adverse effects could result from exposure to more than one herbicide applied in separate projects because herbicide residues in plants and soil are not expected to persist from one application to another, even for the more persistent herbicides. Silvicultural and range applications are not annual; there are typically many years between applications. None of the 16 herbicides accumulates in human tissues, so exposure of an individual to 2 herbicides at different times would be unlikely to cause simultaneous residues within the body.

Exposures to the herbicides, especially for the public, are normally quite small. The greater exposures considered in the routine-worst case scenarios would occur only very infrequently, and the probability of the accidental exposures is extremely low. Because the probability of a large exposure is small for any one chemical, the probability of large exposures simultaneously to multiple chemicals is negligible.

Cumulative Effects

No one individual member of the public is likely to receive repeated exposures to any of the herbicides because of the remoteness of most treatment units, the widely spaced timing of repeated treatments, and the use of a variety of herbicides for different purposes. In addition, the precautions taken by the BLM in their treatment operations make any dose at all to the public quite unlikely. This risk assessment used the lowest NOELs found in chronic animal laboratory studies for comparison with estimated human doses. The risk analysis results showed that, except for triclopyr, margins of safety for the public from realistic treatment scenarios are greater than 200. Thus, members of the public could receive doses of these herbicides repeatedly over the years, even though the chance of receiving multiple doses is negligible, and still not suffer toxic effects. Some individuals who may be particularly sensitive to triclopyr may experience ill effects but, again, this should occur only in the unusual circumstance of repeated doses. Compared to the levels of exposure to the pesticides used in agriculture and related commercial operations in California, the exposures to humans from BLM operations from year to year would be insignificant. Therefore, cumulative effects on the public should be negligible.

Cumulative effects on workers have been considered throughout this analysis. The risk of workers experiencing toxic effects, including cancer, assumes that they are chronically exposed to these herbicides. Backpack applicators are at greatest risk from cumulative effects.

UNAVOIDABLE ADVERSE IMPACTS

The unavoidable adverse impacts which result from implementation of this program will not be identifiable for the most part until the site-specific projects are identified and EAs done on those specific projects. Some generalized unavoidable adverse impacts can be identified at this time, but these impacts will not necessarily occur in all vegetation control projects as each project is different as are sites to be treated and many of these impacts may be mitigated in some cases.

Short-term air quality impacts from prescribed burns and mechanical methods are expected but standards are not expected to be violated under all alternatives. Under Alternatives 2 and 3 allowable annual timber harvest would decline as would economic returns from timber sales. With vegetation management visual resource quality would be degraded in some cases to a slight degree and cultural resources could be accidentally damaged by mechanical methods. Adverse impacts to social well being would occur no matter which alternative is implemented since with herbicide use some groups would perceive danger from chemical use and with no herbicide use others would be impacted by perceived inaction to control nondesirable vegetation.

SHORT-TERM USES VERSUS LONG-TERM PRODUCTIVITY

Implementation of the proposed vegetation control program would have some short-term effects on the productivity of treated sites. The areas to be treated are currently used for forest production, grazing, wildlife, watershed purposes, and recreation. In the short-term, the loss of target and nontarget vegetation would cause temporary loss of food, cover, and other habitat requirements for wildlife, wild horses and livestock.

Continued use of these areas for these purposes is contingent on future productivity. Controlling the spread of vegetation species that are not conducive to proper forest, grazing, wildlife, recreation, fuels or watershed management would ensure future productivity of these areas. Productivity of the treated areas would be enhanced and increased in the long term.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

Irretrievably committed resources include the loss of some types of vegetation with the implementation of all alternatives.

BENEFIT-COST ANALYSIS OF RANGELAND IMPROVEMENT PROJECTS

The level and effectiveness of range vegetation control on BLM land in the EIS area affects the amount of available forage that could be leased by the Bureau as well as direct and indirect effects on other resources and their values, such as recreation use, wildlife populations, and soil and water protection. A change in the use of these resources would affect the investment analysis. Each of the uses of BLM land has a value; when uses change (either increase or decrease), the mix of benefits and costs changes, affecting the return on the investment.

A primary determinant of whether a range investment project should be undertaken is its economic profitability, the weighing of future dollar benefits against future dollar costs. Benefit-cost ratio and internal rate of return are two investment criteria that can be used to evaluate range projects. For any investment decision, land managers must look at all costs and all benefits. Costs include project preparation time, cost of the project itself including labor and equipment, administrative costs, follow-up time, and monitoring time, plus any maintenance during the life of the project. Consideration of any salvage value is also necessary. Benefits may include, but are not limited to, increases in available forage, wildlife populations, and recreation activities and reductions in erosion.

Land managers look carefully at what kinds of investment packages could yield the greatest return while also meeting grazing management objectives. Investment packages are designed for grazing allotments and can consist of a combination of projects such as utilizing different types of control methods (chemical, mechanical, or fire), seeding the area, developing springs, or building reservoirs. BLM uses a computer program ("SageRam," BLM Manual Handbook H-1743-1) to show estimated costs and benefits over the life of the proposed investment package and to show the benefit-cost ratio and internal rate of return for the allotment.

Chapter 4

Consultation & Coordination

CHAPTER 4

LIST OF AGENCIES, ORGANIZATIONS AND PERSONS TO WHOM COPIES OF THE STATEMENT ARE SENT

Comments on the draft EIS were requested from the following:

FEDERAL AGENCIES

Advisory Council on Historic Preservation

Department of Agriculture - U.S. Forest Service Region 5
- Soil Conservation Service

Department of Commerce - National Marine Fisheries Service

Department of Defense - U.S. Army Corps of Engineers

Department of the Interior - Fish & Wildlife Service
- Bureau of Indian Affairs
- Geological Survey
- Bureau of Mines
- Bureau of Reclamation
- National Park Service

Environmental Protection Agency

STATE AND LOCAL GOVERNMENT

California

Office of Planning and Research (State Clearinghouse)
Department of Food and Agriculture
County Agriculture Commissioners
Department of Forestry and Fire Protection
State Water Resources Control Board
Department of Water Resources
Department of Fish and Game
Department of Parks and Recreation
Department of Transportation
California State Historic Preservation Officer
County of Orange
Riverside County Planning Department
Native American Heritage Commission
Kern County Department of Planning and Development Services
Los Angeles Department of Water and Power
Inyo County Planning Department
Modoc County Planning Department

Nevada

Department of Agriculture
Department of Wildlife

Interest Groups and Companies (partial list)

Humboldt State University
Animal Protection Institute of America
California Native Plant Society
Sierra Club (Several Chapters)
SAFE Alternatives for our Forest Environment
Southern California Edison
Environmental Health Coalition
Environmental Protection Information Center
California Coalition for Alternatives to Pesticides
Defenders of Wildlife
Western Timber Association
Louisiana-Pacific Corporation
Citizens for Mojave National Park
Sierra Pacific Industries
National Resources Defense Council
California Energy Company
Mattole Watershed Salmon Support Group
Pacific Gas & Electric
Pacific Power & Light
Sierra Club Legal Defense Fund, Inc.
Cooperative Extension, University of California
Environmental Science Association
Environmental Defense Fund
National Forest Products Association
Audubon Society Chapters

LIST OF PREPARERS

Though individuals have primary responsibility for preparing sections of an EIS, the document is an interdisciplinary team effort. In addition, internal review of the document occurs throughout preparation. Specialists at the BLM's Resource Area, District, State & Washington Offices provide information and conduct review of the document. Contributions by individual preparers may be subject to revision by other BLM specialists and by management during the internal review.

Name	Primary Responsibility	Related Professional Experience
Mark Blakeslee	Team Leader	Hydrologist, 11 yrs.
Bruce Dawson	Vegetation, Grazing	Range Conservationist 9 yrs.
Mike Ferguson	Wildlife, Threatened & Endangered Species	Wildlife Biologist 11 yrs.
John Key	Climate, Geology, Soils and Water Resources	Soil Scientist, 13 yrs.
Dan Marlatt	Forestry	Forester, 25 yrs.
Sheri Olendorff	Word Processing	Word Processing Operator, Editorial Assistant, 6 yrs.

The Human Health Risk Assessment (Appendix H) and Wildlife and Aquatic Organism Risk Assessment (Appendix L) were adapted from reports prepared for BLM and the USFS through contracts with Labat-Anderson, Inc. The list of preparers for the Human Health Risk Assessment can be found in Supplement to the Western Oregon Program-Management of Competing Vegetation, DEIS; USDI, BLM 1986.

Appendices

APPENDIX A

RESULTS OF SCOPING

On March 20, 1986, a Federal Register notice was published informing the public of BLM's plans to prepare an environmental impact statement (EIS) on the vegetation management program for BLM-administered land in California and northwest Nevada. Shortly thereafter on March 31 a letter outlining the proposed EIS and request for input was mailed to agencies, groups and individuals throughout the area. A similar news release was sent to local newspapers on April 2, 1986. The request for input on important issues and alternatives generated many letters of comment. Coordination was also maintained with the Oregon BLM to keep up-to-date on concerns and issues as well as the current developments resulting from the proceedings of the Ninth Circuit Court and lower court actions regarding application of herbicides. An MOU has been entered into with the Pacific Southwest Region of the Forest Service to allow cooperation by the FS on the EIS. The FS interest is in possibly utilizing portions of the EIS and especially the Human Health Risk Assessment for their nonforestry vegetation management needs.

ALTERNATIVES

The alternatives proposed for consideration were published as part of the scoping process. Some public interest was expressed for increased emphasis on biological treatments or for an Integrated Pest Management alternative. Most comments on alternatives agreed with the alternatives proposed (See Chapter 1, Description of Alternatives Including the Proposed Action).

ISSUES AND CONCERNS ADDRESSED

Listed below are the issues and concerns expressed in scoping letters received.

Air Quality

Effects of smoke from prescribed burns.

Soils

Vegetation control may increase soil erosion and soil pollution.

Water

Herbicides may contaminate streams and affect aquatic organisms and fish.

The persistence of herbicides should be evaluated.

How will impacts to waters be mitigated?

Effect of herbicides on ground water.

Vegetation

What effect will vegetation control have on native plants?

Effects of herbicides on nontarget species.

Effects of herbicides on threatened or endangered species.

Vegetation control may reduce community diversity.

Fish and Wildlife

Herbicide effects on animals.

Loss of wildlife habitat due to habitat losses or changes.

Forest Management

Effect of limited or no herbicide use on timber yields.

Human Health

Need to discuss toxicity of herbicides.

What are long-term effects of herbicides on human health, i.e. cancer, birth defects?

Cumulative effects of chemicals on human health.

Worst case analysis of herbicide effects on health.

Recreation

Impacts to recreation use due to herbicide use in high visitor use areas.

Vegetation control effects on wilderness and wilderness study areas.

Economic Conditions

Cost of vegetation control compared to impacts of undesirable vegetation.

Effects on employment of different treatment techniques.

ISSUES NOT ADDRESSED BECAUSE THEY WERE BEYOND THE SCOPE OF THIS EIS

Should evaluate or eliminate the management actions leading to the need for vegetation control.

These evaluations are done during the BLM's land use planning process which set the land use levels and objectives. The scope of this EIS is to evaluate alternatives of vegetation control which can be utilized to meet the land use decisions previously made through BLM's planning process.

APPENDIX B

PEST RATINGS OF NOXIOUS WEED SPECIES AND NOXIOUS WEED SEED

STATE OF CALIFORNIA
DEPARTMENT OF FOOD AND AGRICULTURE
DIVISION OF PLANT INDUSTRY

January 7, 1986

RATING*	SCIENTIFIC NAME	COMMON NAME
B	Acacia armata	kangaroothorn
A	Acaena anserinifolia	biddy biddy
A	Acaena novae-zelandiae (= A. anserinifolia in part as used previously, and of British and Australian authors.)	biddy biddy
A	Acaena pallida (= A. anserinifolia in part as used previously.)	biddy biddy
B	Aegilops cylindrica	jointed goatgrass
B	Aegilops ovata	ovate goatgrass
B	Aegilops triuncialis	barb goatgrass
B	Agropyron repens	quackgrass
A	Alhagi pseudalhagi	camelthorn
B	Allium paniculatum	panicled onion
B	Allium vineale	wild garlic
A	Alternanthera philoxeroides	alligatorweed
B	Ambrosia trifida	giant ragweed
B	Araugia sericofera	bladderflower
Q	Arctotheca calendula	capeweed as seed or fertile plants
B	Cardaria chalepensis	lens-podded hoarycress
B	Cardaria draba	heart-podded hoarycress
B	Cardaria pubescens	globe-podded hoarycress
A	Carduus acanthoides	plumeless thistle

RATING	SCIENTIFIC NAME	COMMON NAME
A	*Carduus* *nutans*	musk thistle
C	*Carduus* *pycnocephalus*	Italian thistle
C	*Carduus* *tenuiflorus*	Italian thistle
B	*Carthamus* *baeticus*	smooth distaff thistle
B	*Carthamus* *lanatus*	woolly distaff thistle
A	*Carthamus* *leucocaulos*	whitestem distaff thistle
C	*Cenchrus* *echinatus*	southern sandbur
C	*Cenchrus* *incertus*	coast sandbur
C	*Cenchrus* *longispinus* (= *C*. *auciflorus* as used previously.)	mat sandbur
B	*Centaurea* *calcitrapa*	purple starthistle
A	*Centaurea* *diffusa*	diffuse knapweed
A	*Centaurea* *iberica*	Iberian starthistle
A	*Centaurea* *maculosa*	spotted knapweed
B	*Centaurea* *repens*	Russian knapweed
C	*Centaurea* *solstitialis*	yellow starthistle
A	*Centaurea* *squarrosa*	squarrose knapweed
B	*Centaurea* *sulphurea*	Sicilian starthistle
A	*Chondrilla* *juncea*	skeletonweed
B	*Chorispora* *tenella*	purple mustard
B	*Cirsium* *arvense*	Canada thistle
A	*Cirsium* *ochrocentrum*	yellowspine thistle
A	*Cirsium* *undulatum*	wavyleaf thistle
C	*Convolvulus* *arvensis*	field bindweed
A	*Crupina* *vulgaris*	bearded creeper
A	*Cucumis* *melo* var. *dudaim*	dudaim melon

RATING	SCIENTIFIC NAME	COMMON NAME
B	Cucumis myriocarpus	paddy melon
A	Cuscuta reflexa	giant dodder
C	Cuscuta spp. except C. reflexa	dodder
B	Cynara cardunculus	artichoke thistle
C	Cynodon spp. & hybrids	bermudagrass
B	Cyperus esculentus	yellow nutsedge
B	Cyperus rotundus	purple nutsedge
C	Cytisus monspessulanus	French broom
C	Cytisus scoparius	Scotch broom
C	Elymus caput-medusae (= Taeniatherum asperum as used by some authors.)	medusahead
A	Euphorbia esula	leafy spurge
B	Euphorbia oblongata	oblong spurge
A	Euphorbia serrata	serrate spurge
B	Gaura coccinea	scarlet gaura
B	Gaura odorata	scented gaura
B	Gaura sinuata	wavyleaf gaura
B	Gypsophila paniculata	baby's breath
A	Halimodendron halodendron	Russian salttree
A	Halogeton glomeratus	halogeton
A	Helianthus ciliaris	blueweed
A	Heteropogon contortus	tanglehead
A	Hydrilla verticillata	hydrilla
C	Hyoscyamus niger	black henbane
C	Hypericum perforatum	Klamathweed
B	Imperata brevifolia	satintail

RATING	SCIENTIFIC NAME	COMMON NAME
C	*Iris douglasiana*	Douglas iris
C	*Iris missouriensis*	western blue flag
B	*Isatis tinctoria*	dyer's woad
C	*Iva axillaris*	povertyweed
B	*Lepidium latifolium*	perennial peppercress
A	*Linaria dalmatica*	Dalmatian toadflax
B	*Muhlenbergia schreberi*	nimblewill
B	*Nothoscordum inodorum*	false garlic
B	*Nymphaea mexicana*	banana waterlily
A	*Onopordum* spp.	onopordum thistles
A	*Orobanche ludoviciana* var. *cooperi* (= *O. cooperi* as used in Munz' a Flora of Southern California.) (= *O. multiflora* as used in Correll and Johnston's Manual of the Vascular Plants of Texas.)	Cooper's broomrape Cooper's broomrape desert broomrape
A	*Orobanche ramosa*	branched broomrape
B	*Oryza rufipogon*	red rice
B	*Panicum antidotale*	blue panicgrass
A	*Peganum harmala*	harmel
C	*Pennisetum clandestinum*	Kikuyugrass
A	*Physalis virginiana* var. *sonorae* (= *P. subglabrata* as used previously.)	smooth groundcherry
B	*Physalis viscosa*	grape groundcherry
C	*Polygonum coccineum*	kelp
B	*Polygonum cuspidatum*	Japanese knotweed
B	*Polygonum polystachyum*	Himalayan knotweed
B	*Polygonum sachalinense*	giant knotweed
A	*Prosopis strombulifera*	creeping mesquite

RATING	SCIENTIFIC NAME	COMMON NAME
B	*Rorippa austriaca*	Austrian fieldcress
C	*Salsola australis* (= *S. iberica*)	common Russianthistle
Q	*Salsola collina*	spineless Russianthistle
C	*Salsola paulsenii*	barbwire Russianthistle
A	*Salsola vermiculata*	wormleaf salsola
B	*Salvia aethiopis*	Mediterranean sage
A	*Salvia pratensis*	meadow sage
Q	*Salvinia auriculata* complex (consisting of *S. auriculata*, *S. biloba*, *S. herzogii*, and *S. molesta*.)	salvinia
A	*Scolumus hispanicus*	golden thistle
B	*Senecio jacobaea*	tansy ragwort
B	*Senecio squalidus*	Oxford ragwort
B	*Setaria faberi*	giant foxtail
C	*Sida leprosa* var. *hederacea*	alkali mallow
A	*Solanum cardiophyllum*	heartleaf nightshade
B	*Solanum carolinense*	Carolina horsenettle
A	*Solanum dimidiatum*	Torrey's nightshade
B	*Solanum elaeagnifolium*	white horsenettle
B	*Solanum lanceolatum*	lanceleaf nightshade
B	*Solanum marginatum*	white-margined nightshade
A	*Sonchus arvensis*	perennial sowthistle
C	*Sorghum halepense*	Johnsongrass and other perennial *Sorghum* spp. including but not limited to *Sorghum almum* and perennial sweet sundangrass.
A	*Sphaerophysa salsula*	Austrian peaweed
A	*Stipa brachychaeta*	puna grass

RATING	SCIENTIFIC NAME	COMMON NAME
A	Striga lutea (= S. asiatica.)	witchweed
B	Symphytum asperum	rough comfrey
A	Tagetes minuta	wild marigold
C	Tribulus terrestris	puncturevine
B	Ulex europaeus	gorse
B	Viscum album	European mistletoe
A	Zygophyllum fabago var. brachycarpum	Syrian beancaper

*Description of Ratings

"A" - Eradication, quarantine regulation, containment, rejection, or other holding action at the state-county level. Quarantine interceptions to be rejected or treated at any point in the state.

"B" - Eradication, containment, control or other holding action at the discretion of the commissioner.

"C" - State endorsed holding action and eradication only when found in a nursery; action to retard spread outside of nurseries at the discretion of the commissioner; reject only when found in a cropseed for planting or at the discretion of the commissioner.

"Q" - Temporary "A" action at the state-county level pending determination of a permanent rating.

FEDERAL NOXIOUS WEED REGULATION, CFR 360

The following plants, seeds, or other parts capable of propagation are within the definition of a "noxious weed" under the Federal Noxious Weed Act of 1974 (7 USC 2802(c)). Listed noxiuos weeds may be moved into or through the United States only under permit from the USDA Plant Protection and Quarantine programs, and under conditions that would not involve a danger of disseminating the weeds. For material moving within the state, a state permit is sifficient.

a. Aquatic Weeds:

Azolla pinnata
Eichhornia azurea
Hydrilla verticillata
Hygrophila polysperma
Ipomoea aquatica
Lagarosiphon major
Limnophila sessiliflora
Monochoria hastata
Monochoria vaginalis
Sagittaria sagittifolia
Salvinia auriculata
Salvinia biloba
Salvinia herzogii
Salvinia molesta
Sparganium erectum
Stratiotes aloides

b. Parasitic Weeds:

Aeginetia ssp.
Alectra ssp.
Cuscuta spp. (See 7 CFR 360.200 for 53 exceptions)
Orobanche spp. (See 7 CFR 360.200 for 13 exceptions)
Striga spp.

c. Terrestrial Weeds:

Ageratina adenophora
Alternanthera sessilis
Asphodelus fistulosus
Avena sterilis (including A. ludoviciana)
Borreria alata
Carthamus oxyacantha
Chrysopogon aciculatus
Commelina benghalensis
Crupina vulgaris

c. Terrestrial Weeds (cont.)

Digitaria scalarum
Digitaria velutina
Drymaria arenarioides
Emex australis
Emex spinosa
Euphorbia prunifolia
Galega officinalis
Heracleum mantegazzianum
Imperata brasiliensis
Imperata cylindrica
Ipomoea trilobata
Ischaemum rugosum
Leptochloa chinensis
Lycium ferocissimum
Melastoma malabathricum
Mikania cordata
Mikania micrantha
Mimosa invisa
Mimosa pigra var. *pigra*
Nassella trichotoma
Opuntia aurantiaca
Oryza longistaminata
Oryza punctata
Oryza rufipogon
Paspalum scrobiculatum
Pennisetum clandestinum
Pennisetum macrourum
Pennisetum pedicellatum
Pennisetum polystachion
Prosopis alpataco
Prosopis argentina
Prosopis articulata
Prosopis burkartii
Prosopis caldenia
Prosopis calingastana
Prosopis campestris
Prosopis castellanosii
Prosopis denudans
Prosopis elata
Prosopis farcta
Prosopis ferox
Prosopis fiebrigii
Prosopis hassleri
Prosopis humilis
Prosopis kuntzei
Prosopis pallida
Prosopis palmeri
Prosopis reptans
Prosopis rojasiana
Prosopis ruizleali
Prosopis ruscifolia
Prosopis sericantha
Prosopis strombulifera
Prosopis torquata
Rottboellia exaltata
Rubus moluccanus
Saccharum spontaneum
Salsola vermiculata
Setaria pallide-fusca
Solanum torvum
Tridax procumbens
Urochloa panicoides

NOXIOUS WEEDS[1/] ON PUBLIC LANDS
ADMINISTERED BY THE BUREAU OF LAND MANAGEMENT
CALIFORNIA STATE OFFICE

Scientific Name Common Name	Rating [2/]	District(s)	Distributional Notes
Alhagi pseudoalhagi camelthorn	A	California Desert	Various localities in Riverside and Imperial Counties.
Cardaria draba heart-podded hoarycress	B	California Desert Susanville	Occurs in western Colorado and western Mohave deserts; a very scattered roadside weed throughout the Susanville District.
Cardaria pubescens globe-podded hoarycress	B	Susanville	A very scattered roadside weed throughout the District.
Centaurea repens Russian knapweed	B	Susanville	Found in a small patch near Ramhorn Springs Campground, Lassen County.
Centaurea squarrosa squarrose knapweed	A	Susanville	Scattered locations in Modoc County--50 to 100 acres.
Centaurea sulphurea Sicilian starthistle	B	California Desert	Western Mojave Desert.
Chorispora tenella purple mustard	B	California Desert Susanville	On disturbed areas, roadsides, mines, etc., in the California Desert; scattered sites in Lassen County, Susanville District.
Cirsium arvense Canada thistle	B	Susanville Ukiah	Scattered in small patches in Modoc County--estimated 30 acres. King Range National Conservation Area and coastal sites in Humboldt and Mendocino Counties.
Cucumis melo var. dudaim dudaim melon	A	California Desert	Eastern Colorado Desert.
Cyperus esculentus yellow nutsedge	B	California Desert	Southern Mojave and western Colorado Deserts.

Scientific Name Common Name	Rating 2/	District(s)	Distributional Notes
Cyperus rotundus purple nutsedge	B	California Desert	Western Colorado Desert.
Gypsophila paniculata baby's breath	B	Susanville	A few scattered sites in Lassen and Modoc Counties.
Halogeton glomeratus halogeton	A	Bakersfield California Desert Susanville	Located in about 30 acres of public land near, Benton, Bakersfield District; occurs in the northern Mojave Desert (Fish Lake Valley) in the California Desert District; occurs on scattered sites in the eastern part of the Susanville District along roadsides and in heavily grazed sites (ca. 200-300 acres in Washoe County, Nevada).
Heteropogon contortus tanglehead	A	California Desert	Western Colorado Desert.
Imperata brevifolia satintail	B	California Desert	Western Colorado Desert; northern Mojave Desert.
Onopordum spp. onopordum thistles ("Scotch thistle")	A	Susanville	Occurs in patches on about 8000 acres in Modoc County; about 1 acre in Lassen County.
Orobanche ludoviciana var. cooperi Cooper's broomrape	A	California Desert	Widespread throughout District.
Salsola vermiculata wormleaf salsola	A	Bakersfield	Scattered over about 10 acres in the Temblor Range; introduced as part of a range experiment in 1969.
Salvia aethiopis Mediterranean sage	B	Susanville	Occurs north of Alturas, Modoc County, near intersection of Highways 395 and 299; other infestations in Alturas-Likely area and in the Tablelands near Willow Creek, Lassen County. May be slowly expanding range.

Scientific Name Common Name	Rating 2/	District(s)	Distributional Notes
Solanum elaeagnifolium white horsenettle	B	California Desert	Eastern Colorado Desert; eastern and western Mojave Desert.
Sonchus arvensis perennial sowthistle	A	California Desert	Western Colorado Desert.

1/ Includes only those weeds rated as A or B by the California Department of Food and Agriculture.

2/ Rating is that given by the California Department of Food and Agriculture. Definitions, based on actions to be taken by the State and Counties, are as follows:

"A" - Eradication, quarantine regulation, containment, rejection, or other holding action at the state-county level. Quarantine interceptions to be rejected or treated at any point in the state.

"B" - Eradication, containment, control or other holding action at the discretion of the County Agricultural Commissioner.

APPENDIX C

VEGETATION MANAGEMENT PRACTICES

RANGE IMPROVEMENTS

Range improvements are undertaken to facilitate livestock management, improve range condition, improve watershed condition and improve the production of livestock forage. Treatments normally are conducted to remove or reduce competition by undesirable or less palatable species. Treatments are often followed by seeding of desirable species. Herbicide use, mechanical methods and prescribed burning are the three major types of treatments used for range vegetation control. Broadleaf selective herbicides are applied to sagebrush to kill the sagebrush and allow grass species to grow with less competition. Mechanical treatments would primarily involve chaining or tilling of sagebrush to remove or disturb the sagebrush plants. Chaining involves dragging a large anchor chain between two dozers which crushes and pulls the sagebrush plants from the soil. Tilling can also be used to dislodge the sagebrush from the soil. The sagebrush is either left in place, burned, or windrowed after being disturbed.

Prescribed burning of rangelands is also done to kill sagebrush, junipers or other brush which interferes with the production of grass species. Burning is done at the time of year when damage to the target plants would be greatest in relation to damage to more desirable species.

Manual treatment in the form of cutting juniper trees with chainsaws is also done to allow more soil moisture and sunlight for grass species and thus better grass production. A beneficial by-product of this is the sale of the juniper wood for fuelwood.

TAMARISK ERADICATION

A combination of manual and herbicide treatment is proposed for control of tamarisk which has invaded desert riparian areas and is destroying valuable wildlife habitat. The process involves cutting the tamarisk trunks low to the ground with either pruning lopping shears or a handsaw and then directly applying picloram to the cut trunk. Retreatments consist of controlling sprouts by the same method and removing shallow roots. Often plantings of native cottonwood or willow may follow herbicide eradication if natural establishment is expected to be slow.

CHAPARRAL MANAGEMENT

Chaparral management is primarily done by prescribed burning, however, results can be improved with pretreatments of herbicide application, mechanical and manual treatments. Chaparral management is undertaken to reduce fuel loading to reduce wildfire hazard by removing decadent stands of chaparral which have heavy accumulations of dead vegetative material. Management also results in more openings and diversity for wildlife thus improving their habitat. Range values are also improved, while water yield to streams can be increased. Burning is done by prescription i.e.,.

a specified area is burned under designated fuel moisture and weather conditions. The pretreatments are used to contain the burn treatment by use of manual and mechanical means to clear firelines and fuelbreaks or to improve the fuel condition to carry the fire better. The chaparral will not always carry the fire satisfactorily so pretreatment is sometimes necessary about a year before the planned burn.

The pretreatment to improve the burn would be done by crushing of vegetation by dozers dragging chains between them or with a chain connected to a large metal ball which is downslope from the dozer pulling the chain. The chaparral is also pretreated by applying herbicide to either kill or partially kill the brush before burning (Green and Carter 1985). Either way the brush must be burned or fuelloads are artificially increased.

REFORESTATION SITE PREPARATION

Site preparation treatments are used to prepare newly harvested or inadequately stocked areas for planting a new crop of trees. The primary treatment objectives are to provide planting spots and planting crew access by reducing slash and to improve plantation success by reducing vegetation that competes with conifers. Four methods of site preparation (burning, chemical, mechanical and manual) are planned for use on BLM-administered lands in California.

Broadcast burning clears areas for planting, reduces fire hazard and reduces competing vegetation. Slash piles are burned to reduce habitat of animals that damage conifers. Burning would be done when weather and fuel conditions are favorable, usually between March and November.

All burning would be conducted in accordance with Fire Management Policy (BLM Manual 9210) which requires the preparation of a prescribed burning plan in advance of every burn. The fire plan tailors each burn to specific requirements of the site. It addresses physical characteristics of the burn area, objectives of the burn, fuels on site (loading and characteristics), weather conditions under which the plan will be implemented, expected fire behavior, air and water quality restrictions, lighting sequence, emergency fire suppression plan, equipment and personnel needs, public contacts and safety.

Site preparation treatments using herbicides are used to increase plantation survival rates by controlling grasses, forbs, brush and noncommercial tree species prior to planting. These treatments improve the potential for success by reducing competition for light, moisture and soil nutrients. In some cases, herbicides would be applied prior to burning to desiccate vegetation, creating drier fuels for improved combustion.

Stage of plant growth and season of application are especially important in prescribing herbicide treatments. All plants exhibit seasonal changes in susceptibility to herbicides, and these changes vary widely. Information on the most effective timing of applications is found in published research and on individual herbicide labels.

Herbicides are applied in a number of ways depending upon the treatment objective, topography of the treatment area, target species, crop species, anticipated costs, equipment limitations and potential environmental impacts. Aerial application is done by helicopters. Ground application is accomplished through injection, backpack spraying, vehicle-mounted spray systems and stump treatment. Injection involves cutting slits in the stems of target plants and applying herbicide into the slits using hand-held containers or injectors. Backpack systems use either a pressurized sprayer or a powered mist blower to apply herbicides as a broadcast spray or directly to individual plants or small concentrations of plants. Vehicle-mounted spray systems incorporate hand-held spray nozzles or fixed nozzles and can be used to treat some flat areas. Stump treatment normally involves the direct application of liquid herbicides to stumps.

In mechanical site preparation, machines are used to provide access to planting spots and reduce competing vegetation. The most common methods consist of scarification and piling or windrowing of slash, brush and unmerchantable trees, using a tractor equipped with a brush blade. Occasionally, circumstances require the use of specially designed mowing attachments or machines (e.g. Hydro-axe) which cut or crush all vegetation on the site. Use of tractors would be restricted to slopes less than 35 percent with low soil moisture and suitable soil types.

While not normally defined as a site preparation method, gross yarding of unmerchantable material during or following logging operations is sometimes used to reduce fire hazard, improve access to planting spots and reduce smoke if the site is burned.

Manual methods of site preparation utilize hand labor to remove competing vegetation and prepare planting spots. Manual methods are normally used where they are effective and where environmental reasons preclude the use of burning, herbicides or mechanical methods. Manual methods used include hand cutting and clearing.

Hand cutting and clearing is done with hand tools, including power saws. It involves activities such as scalping cutting stems of competing vegetation and cutting holes in slash concentrations to clear spots for planting. Hand cutting of green brush is occasionally done prior to burning to increase amounts of dry fuel and improve results of burning.

TREE PLANTING

Planting would be accomplished by hand or mechanical planting machines. Machine planting can only be used on easily accessible and relatively flat sites. Most of the ground to be planted is not suitable to machine planting so would be planted by hand.

Planting is normally accomplished in the spring in areas of significant snow pack and late fall to early spring in other areas. Planting is done as soon as possible after site preparation, logging, fire or other disturbance.

PLANTATION MAINTENANCE AND RELEASE

Vegetation management practices which are applied after planting are termed either maintenance or release treatments. Maintenance treatments promote the survival and establishment of conifer seedlings. Release treatments reduce competition between shrubs or grass and existing commercial conifer seedlings and promote dominance and growth of established conifers.

Fast-growing brush and hardwoods overtop and suppress slow-starting conifer seedlings. Brush and hardwoods grow rapidly, shutting out essential light and competing for water during the dry summer. On most sites, grass and forbs also compete effectively for water. The degree and type of competition vary by site. With reduced competition, conifers grow beyond the point where they can be overtopped and further suppressed by surrounding vegetation. When this growth is achieved (approximately 10 to 20 years from planting), no further control of competing vegetation is necessary except precommercial thinning.

The primary methods of maintenance and release are mowing or crushing, mulching, hand pulling and cutting, scalping grazing, and herbicide application.

Mulching involves covering the ground with paper, woodchips, plastic or other material to prevent growth of competitors around seedlings. Scalping involves removal of competing vegetation with hand tools exposing mineral soil.

Mowing or crushing, is accomplished with a variety of equipment such as rubbertired skidding, or tractors with rotary or flailing attachments which reduces the brush to chips or shreds.

Hand pulling is possible only for plants arising from seed and is not effective on sprouted brush with well developed root system . It is primarily used on young ceanothus, scotch broom and manzanita prior to the second growing season.

Hand cutting for maintenance and release is the same as that for site preparation, except it is limited to cutting of competitive brush and hardwood species, usually in proximity to conifers. Cost and biological effectiveness are highly dependent on terrain, soils, season of treatment, age and size of conifers to be released and the species, age, quantity and size of target vegetation.

Herbicides have been used effectively to inhibit the growth of vegetation competing with conifers. In addition to the application methods identified under Site Preparation the following information (from Gratkowski 1975) concerning the timing of applications is specific to herbicide maintenance and release spray programs.

Correct timing in applying herbicide sprays is essential in releasing young conifers from brush and grass competition. As a result of physiological differences between hardwoods and conifers, many brush species and unwanted hardwood trees are susceptible to herbicide sprays during periods when conifers are resistant. Maintenance and release sprays are applied during five periods of the year when they will control competing vegetation with minimum adverse effect to conifers. These periods are bud break, early foliar, late foliar, late summer and fall. Conifers are closely observed before and during all herbicide operations to determine correct timing of application and hold damage to negligible levels. Stump treatments or individual tree injection methods may take place at any time of the year.

Bud-break sprays are usually applied in late winter or early spring after brush and hardwoods begin growth, but before bud break of the conifers. Oil carriers are used to facilitate absorption of herbicides through the bark of stems and branches. Early foliar sprays are applied in late spring after approximately three-fourths of the new leaves on brush species and hardwoods are fully developed. For conifer maintenance and release during this period, sprays are applied primarily in water carriers. Late foliar sprays are applied primarily in early summer after brush species have ceased active growth, all leaves have fully developed and hardened and terminal buds have formed. Late summer sprays are applied in late July through September, long after most brush species and conifers have ceased growth. Fall sprays are applied from September through November as a plantation maintenance treatment to control grasses and forbs.

PRECOMMERCIAL THINNING

Precommercial thinning is normally applied to conifer stands between 20 and 40 years of age which contain over 500 stems per acre. Precommercial thinning reduces competition and promotes vigorous growth of desirable trees by removing excess trees, trees of inferior form or quality and trees of less desirable species.

The number of trees cut per acre during precommercial thinning is dependent on the density of the stand before thinning. While average spacing is approximately 12 feet, the number of crop trees left may vary between 200 and 320 per acre. Contract specifications, emphasized by field instructions to crews, cover desired spacing of crop trees and criteria for crop tree selection.

The primary method of precommercial thinning is cutting trees with a power saw. The injection of herbicides using specially designed tools is another method available.

APPENDIX D

PROJECT DESIGN FEATURES

This appendix outlines the standard operating procedures which will be applied to all vegetation control efforts. Additional actions or more restrictive procedures are likely to be identified during site-specific pretreatment surveys as outlined below and during the EA process for each project.

PRETREATMENT SURVEYS

Documentation of the following information is required as a minimum when conducting pretreatment vegetation management field surveys.

1. Management program/objective for the site.

2. Consideration of all feasible vegetation management alternatives.

    a) Identification of environmental effects of each alternative--fish, wildlife, soil, water, air, rare/endangered plants and animals.

    b) Human safety associated with each method.

    c) Effectiveness of each method (retreatment needs).

    d) Cost of each method.

    e) Specificity of each method--hazard to nontarget species.

    f) Map of survey unit(s).

3. Recommended treatment methods (combinations).

4. If chemical pesticides are recommended, the following additional information is required.

    a) Herbicide, application rate, carrier.

    b) Posting requirements.

    c) Positive placement techniques planned to minimize drift and effects on nontarget areas.

    d) Method of application.

    e) Special restrictions on the herbicide label concerning handling, buffer strips, grazing, planting, wind speed, and droplet size.

    f) Monitoring needs (water).

HERBICIDE PROJECT DESIGN FEATURES

Buffer Strips

Minimum buffer strips will meet or exceed state-mandated protected buffer strips for all herbicides applied next to live streams, lakes, or ponds. Wider buffer strips will be applied if a requirement is stated on the herbicide label.

Aerial applications require that a 500-foot unsprayed buffer strip be left next to inhabited dwellings unless waived in writing by the resident. A buffer strip of at least 100 feet will be left next to cropland and barns.

Application Contract Requirements

Most of the herbicides used in the EIS area are applied by contractors, who normally both supply and apply the chemicals. In the case of noxious weed control often the contractor is the state or county agricultural district.

1. Contracts for applying herbicides will require that the water intake system for mixing be arranged so that an air gap or reservoir will be placed between the live water intake and the mixing tank to prevent any backflow of chemical into the water source.

2. Contracts for application will require that contractors not wash out spray tanks in or near streams or dispose of chemical containers on the contract area. Chemical containers should be rinsed according to label instructions and disposed of at sites approved by the state.

3. During aerial spraying, spray will be turned off at the end of spray runs and while the aircraft is turning to start another run. Initial spray swaths along buffer strips or areas to be protected will be made parallel to these areas and before the rest of the project is sprayed.

4. Herbicides will be mixed and loaded in an area where an accidental spill cannot flow into a stream or water body.

5. Herbicides will not be applied to asphalt or other types of paved roads.

6. Aerial application equipment will be equipped with no-drip nozzles that use a vacuum or syphon automatic shutoff system or ball check valve that will draw the chemical back from the boom when not spraying. Spray nozzles on the boom will not be extended horizontally on the boom to more than 6/7 of the length of the helicopter rotor.

7. In aerial applications, the contractor will provide at least one qualified person for each mixing truck to handle fueling, mixing spray solutions, and loading. The contractor will also provide a foreman for each heliport to supervise operations. The foreman will be equipped and trained to take remedial action for equipment malfunctions or spills of herbicide or herbicide carrier mixes.

8. To reduce drift and volatilization (see Glossary), aerial spraying will be prohibited when any of the following conditions exist on the spray area: wind velocity exceeds 5 miles per hour; rain or expected rain reduces or will reduce the effectiveness of the chemical being applied; fog obscures the visibility of the target area; air turbulence (thermal updrafts) is so great as to seriously affect the normal spray pattern; or temperature inversions could lead to offsite movement of the spray.

   Label directions will be followed instead of the above restrictions if the directions prescribe different conditions of use. Low volatile formulations of phenoxy herbicides will be used to reduce the potential for offsite contamination.

9. During application, weather conditions will be measured hourly by trained personnel at spray sites. More measurements will be taken whenever a weather change appears to have the potential to jeopardize safe placement of the spray on the target area.

10. Helicopters will normally be required to fly at an air speed of 40 to 50 miles per hour at a safe distance above the vegetation. Spray pressure in the boom will normally be 20 to 35 pounds per square inch. Maximum drift reduction techniques will be used with normal spray formulations and application equipment.

    Herbicide labels may specify boom pressures, air speeds, aircraft heights, and nozzle configurations desirable to reduce drift and increase effectiveness. In the event of a conflict, the label specifications will be followed instead of the above requirements.

11. During air operations, a radio network will be maintained to link all parts of the project, and direct radio communications will be established between spray aircraft and ground crews.

12. On herbicide application projects conducted directly by BLM personnel, a licensed (certified) employee will monitor and supervise the project. Contractors will be licensed according to state and Federal law. A BLM project inspector will ensure compliance with contract requirements.

13. Buffer strips (or no-spray areas) will be determined by individual states. Buffer strips may also be designated by the contracting officer's authorized representative (COAR) or the project inspector during operations as a means to protect undetected rare plants, critical riparian zones, and other sensitive areas.

14. No more than one broadcast application of picloram will be made on a given site in any given year to reduce the potential for picloram accumulation in the soil.

MECHANICAL PROJECT DESIGN FEATURES

1. Mechanized treatments should not be conducted on slopes greater than 40%.

2. Treatments which compact and disturb soil to the degree that runoff and erosion will be increased should be ripped and waterbarred.

PRESCRIBED BURNING PROJECT DESIGN FEATURES

1. Burn on days permitted by California Air Resources Board.

2. Burn when winds aloft will carry smoke away from population centers.

3. Burn when inversions are not present or at elevations above the inversion layer (usually 2,500-3,000 feet in this area).

4. Strive for high dead to live ratios of standing brush (35-40% optimum).

5. Crush and chain perimeter lines, and interior brush within the limits of terrain and economic feasibility.

6. Although high intensity fires result in cleaner burns, prescribed fires must be conducted at relatively low intensity to meet other resource objectives.

7. Leave buffer zones along water courses to reduce negative effects on streams.

8. Burn at a season of year to minimize total vegetation removal such as during spring months or late fall periods.

9. Select sites with soil types, topography, physiography, and climate that are best suited to minimize damage to soil resource. Burn when soils are wet.

10. Limit line construction as much as possible by making use of existing roads, trails, firebreaks, and natural terrain barriers. Water bar and seed firelines as may be required.

11. Limit chaining and brush crushing preparation work to slopes less than 30%.

12. Limit new fireline construction to slopes less than 50%.

13. Leave sparsely vegetated areas on slopes greater than 50% unburned. Handlines, wetlines, and night firing techniques can be used to protect these areas within the perimeter of a burn area.

14. It is recommended that prior to burning and during the individual EA site evaluation that each burn area be evaluated for erosion hazards based on the local geology. Each site should be evaluated for steeply dipping or sloping rock outcrops, rock units of an unconsolidated nature, historic landslides, erodibility of soils and rocks, proximity to active faults (faults which have a history of movement in the last 10,000 years), inclined clay layers which could slip when saturated with water from heavy rains, and slopes which have been undercut by streams or roads.

15. Maintain a 50-foot buffer zone along riparian areas.

16. Generally most fuel reduction burns will be on a 10- to 15-year cycle. Wildlife burns are planned for a 10-year cycle. Range improvement burns are more frequent, 3 to 5 years, since type conversion from brush to grass is the objective.

WATER MONITORING AND STUDIES

To determine the effectiveness of buffer strips and administrative controls in reducing impacts on water quality and the aquatic environment, BLM will monitor water quality as appropriate to the actions implemented. Each district will evaluate its monitoring needs. When an annual spray program is developed, each district will determine the location of streams and areas that might require special attention, such as domestic water supplies and fish hatcheries. The district will then use this information in establishing priority sampling areas. When reviewing the locations of planned herbicide treatments, the district specialist responsible for water quality monitoring will select sites for water quality sampling.

Monitoring schedules will be designed to allow sampling when concentrations are most detectable. In addition, contingency plans will be developed to permit sampling during any phase of the treatment program should a situation arise that requires a quick reaction. Control samples will be taken before treatment, ideally within 24 hours of the treatment period. The sample should be taken from the same site as the other monitoring samples.

Any stream may be considered for water quality sampling, but all waters need not be sampled. To aid in selecting streams for monitoring, a priority system has been developed to give highest priority to streams with important fisheries, extensive human use, or a potential for major environmental impacts. The following are priorities for which monitoring is considered:

1. municipal watersheds;
2. fish hatchery supply watersheds;
3. domestic and agricultural watersheds;
4. major fish-bearing streams; and
5. unique situations.

Monitoring should also be considered in the following other situations.

1. The stream is not a special attention stream but contains an important population of resident fish.

2. The stream flows into a marsh or lake within 5 miles downstream from the treatment area. Herbicide dissipates gradually in flowing water but accumulates in quiet areas such as lakes or marshes. In the lakes or marshes, the herbicide can kill or injure rooted or planktonic plants.

3. Thirty percent or more of a watershed is being treated in one year, especially during winter and spring when many small ephemeral and intermittent streams are flowing. Any herbicide entering a small stream will be quickly diluted when the stream merges with other streams. But if several areas in a watershed are treated, the dilution effect may be lost. In watersheds with extensive herbicide treatment where the dilution effect may be reduced, sampling should be considered, at least on the larger streams downstream from the treatment area.

4. The watershed is considered to be socially sensitive. Public interest is often much greater in some areas than others. Those areas for which the public has expressed the most interest should be considered for water quality monitoring.

APPENDIX E

ANALYSIS OF PROGRAM COSTS

Program costs were analyzed to provide a monetary basis for comparing the alternatives. The average costs presented below include costs of chemicals, labor, equipment and administration of the treatment. Costs do not include EIS preparation, litigation, accidents or training. The costs used are estimates based on past projects within California and the costs used by the Northwest Area Noxious Weed Control Program EIS (USDI BLM 1985). It should be understood that different projects within the same treatment category have variable costs depending on the characteristics of each project.

Vegetation Management Program Costs

	Cost/Acre 1/	Alt. 1	Alt. 2	Alt. 3
Aerial Application	$30	$156,000	$ 0	$ 0
Ground Vehicle Application	$50	40,000	40,000	0
Ground Hand	$130	117,000	149,500	0
Manual	$235	117,500	117,500	282,000
Mechanical	$100	240,000	280,000	335,000
Prescribed Burning	$10	260,000	260,000	260,000
Total Cost		$930,500	$847,000	$877,000
Total Acres Treated		35,800	31,250	30,550
Cost Per Acre		$25.99	$27.10	$28.75

1/ Not all costs are incurred by BLM. Costs on R-O-Ws and leases would be incurred by permittees. Weed control costs are at least partially paid by counties and/or state, while a great deal of volunteer labor or contributed costs are received by BLM for prescribed burns and tamarisk control.

APPENDIX F

ENVIRONMENTAL FATES OF CHEMICALS

AMITROLE

Common Name: Amitrole

Chemical Name: 3-Amino-1,2,4-triazole

Major Trade Name: Amitrol T; Amino Triazole

Major Applications: Nonselective herbicide for confer release, general weed control, range improvement and rights-of-way maintenance.

Amitrole is a nonselective systemic triazine herbicide used for control of a variety of annual and perennial grasses and broadleaf weeds. The expected application rate would be approximately 2 lbs. active ingredient per acre.

Uptake of amitrole in plants is through leaves and roots with translocation through the plant to other structures. It is readily metabolized to a variety of compounds within the plant.

In soil amitrole is adsorbed to colloids or complexed with metallic ions. It has a persistence of less than one month in soil and is degraded through oxidation, adsorption and microbial degradation. Amitrole has a low volatility and thus volatilization is not a route of loss of amitrole. Amitrole is more readily leached from sandy soils due to lack of organic matter for adsorption. Amitrole persistence in soil is decreased with increased soil moisture, higher soil temperature, pH higher than 7.0, low base exchange capacity and high clay and organic matter content.

While amitrole is soluble in water and may persist in aquatic conditions it is readily adsorbed onto bottom sediments and metabolized by algae species. In addition studies have shown that under normal field applications appreciable amounts of amitrole residues do not show up in stream systems. In cases where amitrole has been detected in streams adjoining sprayed areas, it was undetectable within short distances downstream due to dilution, adsorption and metabolism.

Amitrole is rapidly eliminated through urine of animals mostly as the parent compound with small amounts of metabolites. It is relatively insoluble in fats and does not tend to accumulate in plants or animals. No studies have been conducted on wildlife but tests with lab animals show low acute toxicity. While amitrole has been shown to be carcinogenic to lab animals in long-term studies the level and length of exposure to wildlife resulting from normal applications of amitrole is much less than the amounts of amitrole required to produce effects on laboratory animals.

The information on amitrole was summarized from USDA, FS 1984. In accordance with 40 CFR 1502.21, this is incorporated into this EIS by reference.

ASULAM

Common Name: Asulam

Chemical Name: Methyl sulfanilylcarbamate

Major Trade Name: Asulox

Major Applications: Used for site preparation, maintenance and release to control bracken fern.

Asulam is a carbamate herbicide used as a selective, post emergence, systemic herbicide on reforestation areas and noncrop areas. It is very useful for the control of bracken fern in reforestation areas. The expected application rate would be approximately 1.2 lbs. active ingredient per acre applied with a water carrier.

Asulam is rapidly absorbed by foliage and roots of plants. Translocation of asulam is moderate and tends to concentrate in the roots. Hydrolysis is one of the major mechanisms of metabolism of asulam.

In soil asulam has been shown to rapidly degrade in a variety of soils, with greater degradation rates in warm, moist soils. Bacteria are important in the asulam degradation process. Adsorption of asulam by soil and organic material is negligible making the mobility of asulam quite high. In one study, while asulam was moved vertically most remained in the upper 15 cm of soil and no residue was detected at any depth after 50 days of application.

Due to the degradation of asulam in soils little residue is available for removal by leaching or surface runoff. In one study asulam levels of 0.5 ppm were detected immediately after treatment with no herbicide residue detected after 2 weeks.

In bracken fern control studies a wide range of upland plant species were not adversely affected by direct spray of asulam. Some kill of flowering species was observed but reestablishment from roots and seeds occurred within 12 months. While there is no information on toxicity to mammalian wildlife asulam has a low level of toxicity to mammalian lab animals. Toxicity to birds and fish has also been shown to be low and no adverse effects to aquatic organisms have been noted.

The detailed information on asulam as summarized above comes primarily from LAI 1986a. In accordance with 40 CFR 1502.21, it is incorporated into this EIS by reference.

ATRAZINE

Common Name: Atrazine

Chemical Name: 2-chloro-4-ethylamino-6-isopropylamino-s-triazine

Major Trade name: Aatrex 80W; Drexel Atrazine 80

Major Applications: Nonselective herbicide for conifer release, site preparation, grass and noxious weed control, and rights-of-way.

Atrazine is a nonselective systemic triazine herbicide used widely on agricultural crops and for forestry, noxious weed control and rights-of-way maintenance. Expected application rate for most uses is 3.75 lbs. active ingredient per acre. Its persistence in soil (3 to 12 months) allows for season-long control of vegetation.

Atrazine is uptaken by plant roots and rapidly translocated throughout the plant with some accumulation in leaf margins. Atrazine is degraded in plants by several methods and the ability of different plants to degrade atrazine reflects the sensitivity of the plant to atrazine's herbicidal effects. Atrazine acts on a variety of plant biochemical processes, including photosynthesis, plant growth regulation, nitrogen metabolism and nucleic acid metabolism.

In soil atrazine is moderately persistent allowing season-long control of vegetation. It is readily adsorbed to high clay and organic soils. Major degradation is through chemical and microbial processes with little photodegradation or volatilization loss. Degradation is increased with warmer temperatures and higher soil moisture. Its low solubility in water and adsorption to soil contributes to its tendency to remain in upper soil layers.

Atrazine is slightly soluble in water thus limiting its probability of showing up in runoff and stream flow. It degrades slowly in water so dilution, transport, and metabolism by aquatic plants, algae and bacteria are primary means for reduction of atrazine in water. Under normal situations only small amounts of atrazine are transported by runoff, mostly during rainfall events within a couple of days after application. In a study where atrazine was introduced into a grond water aquifer the chemical was not detected to move readily through the aquifer.

No studies have been conducted on wildlife with atrazine, but laboratory tests and domestic livestock studies are available. Tests have shown toxicity to aquatic organisms with low to nontoxicity for a variety of animals. Bioaccumulation is low in fish to nil in other animals. Atrazine is degraded to intermediate metabolites which are readily excreted by the kidneys of animals. Tests with livestock show rapid decline of residues to below detectable levels within 2 to 4 days. No tests indicate carcinogenic effects due to atrazine.

The information on atrazine is summarized from USDA, FS 1984. In accordance with 40 CFR 1502.21, this document is incorporated into this EIS by reference.

BROMACIL

Common Name: Bromacil

Chemical Name: 5-bromo-3-sec-butyl-6-methyluracil

Major Trade Name: Hyvar X and XL

Major Applications: Pre- or post-emergence control of broadleaf weeds, grasses and some woody species.

Bromacil is a broad spectrum uracil herbicide used for control of vegetation for reforestation plantings and plantations. Expected application would be either granular or mixed in water at a maximum of 4 lbs. active ingredient per acre. The higher rates would be for control of undesirable woody species.

Absorption by plants is primarily through roots and the amount translocated varies widely among different plant species. The herbicidal action is related to the inhibition of photosynthesis of plants.

Bromacil is moderately persistent and moderately to highly mobile in soil. Adsorption is related to organic and clay content with a lower adsorption and higher mobility than many herbicides. Degradation is mostly through microbial metabolism with negligible photodecomposition and volatilization. Leaching to ground water is a definite possibility especially with high application rates, porous soils and low organic content.

In water bromacil has a low solubility and studies have found only insignificant levels of bromacil in surface runoff.

While no studies have been done on wildlife, studies on livestock show sheep being sensitive to bromacil. Application rates greater than 5 lbs. per acre are considered hazardous to sheep. Cattle showed no similar sensitivity. Bromacil is relatively nontoxic to birds and at normal application rates should have no effect on birds. It is slightly toxic to laboratory mammals and no validated mutagenicity tests are available. One of the two tests for carcinogenicity in rats was positive at relatively high rates of bromacil ingestion. At normal application rates no effects to wildlife would be expected.

The above summary was taken from LAI 1986b. In accordance with 40 CFR 1502.21 this document is incorporated into this EIS by reference.

DALAPON

Common Name: Dalapon

Chemical Name: 2,2-dicloropropionic acid

Major Trade Name: Dowpon M

Major Applications: Grass control for reforestation and rights-of-way maintenance.

Dalapon is an aliphatic acid herbicide moderately selective to annual and perennial grasses. The expected application amount would be less than 4 lbs. active ingredient per acre. Little effect of dalapon on nontarget species has been recorded.

Dalapon is absorbed by plants through both foliage and roots, then readily translocated to areas of high metabolic activity such as new growth, budding, and fruiting. Metabolism of dalapon by plants does not appear to occur although over the long term it is diluted through new plant growth. Dalapon inhibits RNA synthesis, photosynthesis, lipid synthesis and protein synthesis in a descending order of importance in plants. Residues in plants are directly related to application rate with decreases over time.

Persistence of dalapon in soil is very short (less than 1 month). It does not adsorb to soil and has a high solubility in water influencing a high potential for leaching from soil. The major degradation process is microbial activity with chemical degradation and volatilization being minor. Photodecomposition does not appear to occur. While dalapon is highly mobile and readily leachable, actual studies have found less leaching than expected due to rapid microbial degradation. This degradation would be reduced with low temperatures, low moisture, low pH and high organic matter content however.

Dalapon in water is primarily degraded by microbial action and dilution. Due to rapid breakdown in soils only insignificant amounts would normally reach water bodies. Applications of dalapon on ditch banks have measured dalapon in runoff water which quickly disappeared. The levels were also well below amounts toxic to aquatic organisms.

In animals dalapon is generally nontoxic or only slightly toxic. At normal application rates no toxic effects would be expected to aquatic organisms or any other animals. No carcinogenic effects have been demonstrated in dalapon studies. Metabolism of dalapon by animals occurs through hydrolysis to an intermediate metabolite with further degradation to acetate and carbon dioxide. As indicated by its high solubility dalapon does not bioaccumulate in animals.

The above is a summarization of information in USDA, FS 1984 and in accordance with 40 CFR 1502.21 is incorporated into this EIS by reference.

DICAMBA

Common Name: Dicamba

Chemical Name: 3,6-dichloro-o-anisic acid

Major Trade Name: Banvel

Major Applications: To control or suppress growth of many annual, biennial and perennial broadleaf weeds wide variety of situations.

Dicamba is a selective systemic benzoic acid herbicide used for control of a variety of broadleaf plants. Application rate would be expected to be less than 1 lb. active ingredient per acre.

Uptake of dicamba by plants is by both roots and foliage and is readily translocated through the plant. As well as being metabolized in the plant dicamba is lost through the leaf surface and exudation from the roots.

Dicamba has a moderate (3 to 12 months) persistence in soil allowing full-season control. It does not adsorb readily to soil particles and colloids and has a relatively high solubility in water giving it a high mobility in soils. Major degradation of dicamba is through microbial degradation with some volatilization and negligent photodecomposition. More rapid degradation occurs in higher temperatures and moisture and clayey soils.

In water dicamba is highly soluble but due to its readily leaching into soils very small amounts would be expected to enter streams. In studies dicamba has either been quickly diluted or only found at insignificant concentrations after spraying. In ponds dicamba was completely dissipated after 40 days. Breakdown occurs much faster in nonsterile, lighted conditions than in sterile, dark conditions.

In animals laboratory tests have shown low toxicity to organisms and no mutagenic or carcinogenic hazards. There is evidence of reproductive effects in rabbits. Dicamba does not bioaccumulate with most of the dicamba eliminated through urine in a short time period.

The above information is summarized from USDA, FS 1984, and in accordance with 40 CFR 1502.21 is incorporated into this EIS by reference.

DIURON

Common Name: Diuron

Chemical Name: 3-(3,4-dichorophenyl)-1,1-dimethylurea

Major Trade Name: Drexel Diuron 80

Major Applications: As a selective pre- and post-emergence herbicide to control grasses and broadleaf weeds on rights-of-way.

Diuron is a selective systemic urea herbicide for control of broadleaf weeds and grasses. Application rate would be 4 lbs. active ingredient per acre or less, applied as a wettable powder or in granular form.

Diuron is readily absorbed through the roots and rapidly translocated to the upper portion of the plant. Toxicity to plants is generally due to photosynthesis inhibition.

In the soil diuron is persistent (up to 24 months) with a half life of up to 6 months. Degradation is primarily through decomposition by microbial action. Photodecomposition is important only under hot dry conditions when the chemical remains on the surface. It is relatively immobile due to strong adsorption to clays and organics and is one of the least mobile herbicides. Leaching generally produces no detectable levels of diuron in lower soil depths.

Diuron's low mobility results in very small amounts being detected in runoff water. It completely degraded from an abnormally high level in pond sediments under anaerobic conditions in less than 25 days. Diuron may inhibit certain algae growth but adsorption by sediments and organics in natural systems would reduce this possibility.

Diuron is only slightly toxic to mammals. One study states application rates up to 9.6 lbs./acre would be nonhazardous to cattle and sheep. It is toxic to chickens at low levels but tests with quail, pheasants and mallards show toxic effects only at high doses.

Toxic effects on fish occur at moderate levels of diuron with the toxicity dependent on the herbicide formulation. Bioaccumulation has been noted in carp and aquatic invertebrates. Diuron's toxicity to lower aquatic organisms is considered to be quite toxic.

The summarized information above is from LAI 1986c, and in accordance with 40 CFR 1502.21 is incorporated into this EIS by reference.

2,4-D

Common Name: 2,4-D

Chemical Name: 2,4-dichlorophenoxyacetic acid

Major Trade Name: DMA4; Esteron 99 Concentrate and 6E; Formula 40

Major Applications: Used as a selective annual and perennial broadleaf weed killer in grass pastures, rangelands, and noncropland areas.

2,4-D is a selective phenoxy herbicide widely used to control broadleaf plants and shrubs. The expected application rate is 2.5 lbs. active ingredient per acre.

Plants readily absorb, translocate, and metabolize 2,4-D. The formulation influences the degree of absorption. Once absorbed, 2,4-D may be chemically altered by a variety of mechanisms. Residues at phytotoxic levels are believed not to persist in dead vegetation.

2,4-D is considered a relatively nonpersistent herbicide. The 2,4-D acid is degraded mainly by microorganisms. Esters and amines of 2,4-D hydrolyze to acid form within a few days after deposition in the soil. In warm, moist soils with a high organic content, 2,4-D can degrade within days, but 2,4-D can persist for many months in the absence of favorable soil conditions. Leaching of 2,4-D is more extensive in soils with less organic matter and a lower pH. Leaching and adsorption are inversely related. 2,4-D generally remains within the top foot of the soil profile.

In water, esters of 2,4-D are also rapidly hydrolyzed to the acid form. The persistence of the acid depends on the presence of microorganisms adapted to 2,4-D degradation. In cool, nutrient-poor, natural surface waters, 2,4-D may remain stable for many months. Photodecomposition has been shown in the laboratory, but the degree of 2,4-D degradation in the field with natural sunlight is unknown. Volatilization is usually not a major mechanism for removal of 2,4-D from water.

2,4-D is phytotoxic to many nontarget plants, including some crops and ornamentals. The toxicity of 2,4-D to fish highly varies, depending on the species, water quality, and 2,4-D formulation. The acute oral LD_{50} of 2,4-D for some birds ranges from 300 to 5,000 mg/kg. 2,4-D is generally less toxic to birds than to mammals. The toxicity of 2,4-D to honeybees is low. 2,4-D does not tend to bioaccumulate in fish or in mammals. Carcinogenicity was not detected at test dosages. Teratogenic effects were detected at dosage levels ranging from 20 mg/kg/day up to near acute lethal dosages. Mutagenicity studies have resulted in conflicting data.

EPA (1980) recently reviewed all research and concluded that 2,4-D does not pose an imminent hazard and would not cause an unreasonable adverse effect when used according to label precautions.

Detailed information, summarized above, concerning the fate and behavior of 2,4-D in the environmental and potential impacts may be found in the following source documents: Ghassemi et al. 1981; USDA, FS 1984; and DOE, BPA 1983. In accordance with 40 CFR 1502.21, these documents are incorporated into this EIS by reference.

2,4-DP

Common Name: 2,4-DP (Dichlorprop)

Chemical Name: 2-(2,4-dichlorophenoxy) proprionic acid

Major Trade Name: Weedone 2,4-DP; Weedone 170

Major Applications: Postemergence herbicide, often mixed with 2,4-D, for conifer release, rights-of-way maintenance, range management and recreation management.

2,4-DP is a selective systemic phenoxy herbicide used to control broadleaf weeds and woody vegetation. It is proposed to be applied at the rate of 2 lbs. active ingredient per acre.

Plant uptake of 2,4-DP is similar to 2,4-D uptake. It is absorbed through leaves, stems and roots and readily translocated within the plant. Herbicidal activity is due to interference with normal growth processes. Plants readily metabolize phenoxy herbicides by changing the molecular structure. Plant resistance is usually related to the ability to metabolize the phenoxy to a nontoxic metabolite.

In soil persistence of phenoxy herbicides is short, with tests showing 2,4-DP to have a half-life of about 10 days. Compared to other herbicides 2,4-DP is relatively mobile in soils, but influenced by the solubility of the specific 2,4-DP formulation as well as organic content and pH of the soil. Major degradation is through microbial action.

In water behavior is assumed to be similar to 2,4-D and persistence would depend on the presence of microorganisms capable of biodegrading 2,4-DP.

Animals do not bioaccumulate phenoxy herbicides to any great extent. Laboratory tests have shown 2,4-DP to be slightly toxic with carcinogenic and other effects only at levels much higher than expected use levels.

The information on 2,4-DP is summarized from USDA, FS 1984 and in accordance with 40 CFR 1502.21 is incorporated by reference into this EIS.

FOSAMINE

Common Name: Fosamine ammonium

Chemical Name: Ammonium ethyl carbamoylphosphonate

Major Trade Name: Krenite

Major Applications: Used primarily for woody brush and weed control in site preparation, conifer release, wildlife and range improvements.

Fosamine is a selective carbamate herbicide, proposed for control of woody vegetation at the rate of 3 lbs. of active ingredient per acre. Fosamine ammonium is a relatively new herbicide which has been commercially available only in the past few years. The available data on efficacy and environmental fate and impacts are largely from laboratory and field tests with nonforest systems conducted mainly by the manufacturer.

The principal mechanism of fosamine ammonium uptake by plants is through foliage, stems and buds. In the spring following treatment, bud development is suppressed. Susceptible species fail to refoliate or they produce miniature, spindly leaves and die. In soil, fosamine ammonium degrades rapidly via microbial and (to a lesser extent) chemical routes. The major chemical degradation route is hydrolysis to give carbamoylphosphonic acid (CPA), which also degrades rapidly in soil. Fosamine ammonium losses from soil due to volatilization and photodecomposition are not expected to be appreciable. In pasture flora, fosamine ammonium is metabolized to CPA and carboxyphosphonic acid.

Despite its water solubility, fosamine ammonium is a low mobility herbicide. Leaching and desorption from soil are lowest in soils with high clay and heavy metals content. Some fosamine ammonium hydrolysis occurs in water.

Fosamine ammonium is phytotoxic to many nontarget woody forest and nonforest species. Pines are the most susceptible confers, particularly in spring and summer. Krenite has low toxicity to fish and mammals. It is excreted and/or metabolized rapidly by animals and is considered nonbioaccumulable. It is considered nontoxic to soil microorganisms but has been shown to decrease the rate of nitrification of certain algae.

Detailed information, summarized above, concerning the fate and behavior of fosamine ammonium in the environment and potential impacts may be found in the source documents, Ghassemi et al. 1981 and USDA, FS 1984. In accordance with 40 CFR 1502.21, the aforementioned material is hereby incorporated by reference.

GLYPHOSATE

Common Name: Glyphosate

Chemical Name: N-(phosphonomethyl) glycine

Major Trade Name: Rodeo

Major Applications: Glyphosate is used to control many annual, biennial, and perennial broadleaf weeds and grasses in noncropland areas.

Glyphosate is a broad spectrum, nonselective herbicide used to control vegetation in a wide range of situations. Expected application rate for this EIS is 2 lbs. active ingredient per acre.

Because glyphosate is a relatively new pesticide, the environmental fate and potential ecological effects of its use have not yet been extensively studied. The small amount of existing data was obtained almost entirely from greenhouse and laboratory studies with agricultural systems and laboratory animals, studies largely generated by the manufacturer. This data shows glyphosate's high effectiveness, short persistence in soil and water, and low toxicity to animals.

Glyphosate is absorbed almost exclusively via plant foliage and is translocated throughout the plant. Less than 1 percent of the glyphosate in the soil is absorbed via the roots. Glyphosate is apparently not metabolized to a significant degree in plants, and its mode of action is believed to involve inhibition of aromatic amino acid synthesis.

That glyphosate is rapidly and strongly adsorbed to soil particles accounts for its observed lack of mobility, its nonleachability in soil, and its unavailability for root uptake. Adsorption to soil is believed to be through the phosphonic acid component. The phosphate level in the soil influences the amount of glyphosate adsorbed, and glyphosate adsorption is greater in soils with high concentrations of trivalent metals such as aluminum and iron, rather than high concentrations of sodium and calcium.

Dissipation of glyphosate in soil is fairly rapid (half-life of about 2 months) and mainly results from microbial degradation. The main soil metabolite of glyphosate is aminomethylphosphonic acid (AMPA), which itself is also highly biodegradable. Glyphosate is subject to biodegradation in natural waters and has an estimated half-life of 7 to 10 weeks.

At normally recommended application rates, glyphosate should not be toxic to animals. Bioassays on several aquatic invertebrates and fishes have found 96-hr LD_{50} values ranging from 2.3 mg/l for fathead minnows to 43 mg/l for mature scuds. Animal feeding studies with glyphosate have found low toxicity to rat, mallard duck, and quail and little or no potential for bioaccumulation. Teratogenicity was not detected at test dosages. No evidence exists for the carcinogenicity or mutagenicity of glyphosate, although glyphosate can cause skin and eye irritation to applicators.

The following source documents present detailed information on the fate and behavior of glyphosate in the environment and potential impacts: Ghassemi et al. 1981; USDA, FS 1984; and DOE, BPA 1983. In accordance with 40 CFR 1502.21, these documents are incorporated by reference into this EIS.

HEXAZINONE

Common Name: Hexazinone

Chemical Name: 3-cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4(1H,3H)-dione

Major Trade Name: Velpar L; Pronone 10G

Major Applications: Used primarily in the Southwest for site preparation and pine release, to control annual and biennial weeds and woody vines and perennial weeds and grasses.

Hexazinone is a nonselective systemic herbicide. It is expected to be used at 2.5 lbs. of active ingredient per acre. Hexazinone is a relatively new herbicide which is being evaluated as a possible substitute for 2,4,5-T for site preparation and conifer release.

Root uptake is the principal mechanism for the absorption of hexazinone by plants from soils treated with pellets. Hexazinone is translocated to the foliage where it blocks the photosynthesis process. In addition to plant uptake, hexazinone is dissipated in soil via photodegradation, biodegradation and leaching. Depending on field conditions, half-life appears to be independent of the application rate. Laboratory and field leaching tests have indicated that hexazinone and some of its degradation products would be washed into the soil with rainwater. Photodegradation, dilution and biological decomposition are the major factors in reducing hexazinone concentration in natural waters. Hexazinone is relatively mobile and leachable in soils.

In applications of hexazinone for conifer release, 0-15 percent conifer mortality may occur, but this is dependent on species, rate, soil type and other factors. Aquatic toxicity data indicate that hexazinone is only slightly toxic to Daphnia and fish. The product also does not bioaccumulate in fish. Toxicity tests have indicated that hexazinone has low toxicity to birds, wildlife, fish and mammals. From two years of extensive toxicological studies, no evidence of carcinogenicity, teratogenicity or mutagenicity has been found.

Detailed information, summarized above, concerning the fate and behavior of hexazinone in the environment and potential impacts may be found in the source document, Ghassemi et al. 1981 and USDA, FS 1984. In accordance with 40 CFR 1502.21, the aforementioned material is hereby incorporated by reference.

PICLORAM

Common Name: Picloram

Chemical Name: 4-amino 3,5,6-trichloropicolinic acid

Major Trade Name: Tordon 22K and 101R

Major Applications: Picloram is used for the control of broadleaf weeds on rangeland and permanent grass pastures.

Picloram is a wide spectrum herbicide used to control woody and broadleaf vegetation. In this EIS application of 1 lb. active ingredient per acre is expected.

Most information on the fate of picloram in soil and water is the result of laboratory and field studies with agricultural systems.

Picloram is rapidly absorbed by plant roots and less rapidly by foliage. Once absorbed, it is readily translocated throughout the plant and tends to accumulate in new growth. It is highly stable and remains largely intact within the plant. It is possible that some picloram may move from treated species' roots and thus become available in the soil for nontarget species.

Picloram is considered moderately to highly persistent in soils under conditions of normal application and may exist at phytotoxic levels for over one year. Reported half-lives vary from 1 month to over 13 months. Persistence is generally shorter in soils with high organic matter and adequate moisture such as in forest soils and in warm temperatures. Picloram degrades in soil via microbial rather than chemical routes, but amounts of picloram decomposed are small. Picloram photodecomposes on soil surfaces to the greatest extent under intense sunlight.

Picloram is considered a mobile herbicide and is reversibly adsorbed on soil particles. Adsorption is greatest in soils high in organic matter and increases with decreasing pH, particularly in clay soils. Leaching occurs to the greatest extent in sandy, light-textured soils and in soils poor in organic matter. Because of the water solubility of picloram and its salts and its leaching tendencies, runoff from treated areas can contain relatively high concentrations of picloram.

Picloram is phytotoxic to many nontarget plants and is highly toxic to young pine seedlings. Several incidents of damage to nontarget plants from picloram spray drift have been reported. Certain plant species have been injured as long as 5 years after application because of picloram's persistence.

Picloram and its salts are low in toxicity to fish and other aquatic organisms. Picloram also has low toxicity to warm-blooded animals, soil microorganisms, and bees and is rapidly excreted by and does not bioaccumulate in mammals. Picloram in water is not accumulated in invertebrates or in food chains.

New carcinogenicity studies are being conducted. Mutagenicity and teratogenicity have not been detected at test dosages.

The following source documents present detailed information on the fate and behavior of picloram in the environment and potential impacts: Ghassemi et al. 1981; USDA, FS 1984; and DOE, BPA 1983. In accordance with 40 CFR 1502.21, these documents are incorporated into this EIS by reference.

SIMAZINE

Common Name: Simazine

Chemical Name: 2-chloro-4,6-bis(ethylamino)-s-triazine

Major Trade Name: Princep 80W and 4G; Drexel Simazine 80

Major Applications: Selective control of annual and perennial grasses and broadleaved weeds, algae and aquatic plants.

Simazine is used for both selective and nonselective weed control. Expected application rate is 2 lbs. of active ingredient per acre.

Uptake of simazine by plants is primarily through the roots and rapidly translocated to upper plant portions. It is effective on shallow rooted plants but due to low soil mobility does not readily leach to roots of deep rooted plants. Herbicidal action is on a variety of biochemical processes including photosynthesis, plant growth regulation, nitrogen metabolism and nucleic acid metabolism.

In soil simazine is moderately persistent (3 to 12 months) allowing full-season control of vegetation. Simazine has a low solubility in water, moderate mobility in silty clay loam and readily adsorbed onto soil particles. Chemical and microbial degradation are the primary means by which simazine is lost from the soil. It is relatively resistant to leaching due to its adsorbancy and low water solubility especially in higher organic content soils.

Simazine in water is moderately persistent, half-life 50 to 70 days. However, dilution and transport would decrease the effect of this persistence. Removal from aquatic systems would be primarily due to metabolism by aquatic plants, algae and bacteria.

Simazine is only slightly toxic to fish and animals while some nonlethal effects have been recorded on fish and crustaceans at relatively low levels. There have been no studies indicating carcinogenicity due to simazine as of yet. This data is summarized from USDA, FS 1984 and in accordance with 40 CFR 1502.21 is incorporated into this EIS by reference.

TEBUTHIURON

Common Name: Tebuthiuron

Chemical Name: N-½5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-N,N-dimethylurea

Major Trade Name: Spike 80W, 20P, 40P, and Brush Bullets

Major Applications: Broad-specturm herbicide for weed and brush control in range and forest management.

Tebuthiuron is a broad-spectrum soil applied herbicide used for total control of vegetation for range management and for more selective control of vegetation in reforestation. Application rate is expected to be 2 lbs. of active ingredient per acre treated.

Uptake by plants is through the roots at a relatively slow rate. Tebuthiuron inhibits photosynthesis resulting in defoliation of woody plants and depletion of plant carbohydrate reserves, and ultimately death of susceptible plants. Its slow uptake allows for control through the year. Residues of tebuthiuron and its metabolites have been found to remain in forage plants and woody vegetation for relatively long time periods and has been a concern in forage consumed by livestock or for woody vegetation burned later.

Tebuthiuron is relatively persistent in soil and is moderately mobile in soil and will leach from soil slowly. It is degraded primarily through microbial action and thus is degraded faster with warmer temperature and higher soil moisture.

Small amounts of tebuthiuron may be leached into surface water as a result of precipitation and it has a low potential to leach to ground water. In water tebuthiuron will undergo photodecomposition but not hydrolysis.

Tebuthiuron is readily absorbed, metabolized and excreted by animals. It has a relatively low toxicity to animals and is nonmutagenic and noncarcinogenic in tests reported to date. Residues of tebuthiuron and its metabolites do not accumulate in cow's milk or other edible tissue.

This information is summarized from USDA, FS 1985b and in accordance with 40 CFR 1502.21 is incorporated by reference into this EIS.

TRICLOPYR

Common Name: Triclopyr

Chemical Name: 3,5,6-trichloro-2-pyridinyloxyacetic acid

Major Trade Name: Garlon 3A; Garlon 4

Major Applications: Used for site preparation and occasionally in conifer release for woody plants and broadleaf weed control.

Triclopyr is a broad spectrum systemic herbicide and is a relatively new herbicide which has been commercially available only in the past few years. It is expected to be applied at 2 lbs. of active ingredient per acre.

The mechanism of triclopyr uptake by plants is through both leaves and roots. It induces characteristic auxin-type responses in plants. Triclopyr is not considered a persistent compound in soils; it degrades rapidly, with an average half-life of 46 days. The major route of degradation in soil is via microbial decomposition. Degradation of triclopyr does not occur to any appreciable extent via chemical hydrolysis or other chemical routes in soil. Triclopyr losses due to volatilization are not appreciable.

Triclopyr is considered a mobile herbicide. Leaching and desorption are lowest in soils with high organic matter content. Because of its mobility and rapid desorption from soil particles, some loss of triclopyr due to solubilization and/or runoff may be expected following field appliation. Although it is stable to hydrolysis in aqueous solution, triclopyr photodegrades rapidly with a half-life of 10 hours at 25°C.

Triclopyr can cause injury to conifers at high rates of application and must be used carefully for conifer release. When applied directly, it exhibits phytotoxicity to agricultural crops. Triclopyr has low toxicity to fish and lower aquatic organisms and does not bioaccumulate in these species. It exhibits low toxicity to wildlife and is considered nontoxic to soil microorganisms.

Testing produced no carcinogenic or mutagenic effects. It is considered mildly fetotoxic.

Detailed information, summarized above, concerning the fate and behavior of triclopyr in the environment and potential impacts may be found in the source documents, Ghassemi et al. 1981, and USDA, FS 1984. In accordance with 40 CFR 1502.21, the aforementioned material is hereby incorporated by reference.

APPENDIX G

AN ESTIMATE OF CARCINOGENIC RISK ASSOCIATED WITH POLYAROMATIC HYDROCARBONS IN SMOKE FROM PRESCRIBED BURNING IN FORESTRY

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INTRODUCTION

The most important component of an assessment of smoke-derived risk is determination of exposure. Without dependable estimates or measurements of the amounts of combustion products reaching individuals, speculation about effects is pointless. However, some combustion products have minimal biological impact and it should be obvious that there is no point in measuring substances that make no contribution to hazard. It is necessary, therefore, to determine which classes of components must be considered according to either direct evidence of genetic or other activity, or similarity to structures that have known activity. Because many polyaromatic hydrocarbons are known to be carcinogenic, there is public concern about the contribution of prescribed burning to the environmental carcinogenic load. This report on a limited number of the PAH found in smoke is the first step in assessment of the potential environmental health risks associated with smoke from burning of forest residues.

At present, assessment of the risks that might be associated with emissions from slash burning can be only best estimates. Three general factors contribute to this imprecision. Because combustion is ubiquitous in nature and human activity, it is difficult to consider any particular burning activity in isolation. In the case of slash burning, however, there are some characteristics in space and time that make it possible to consider the effects of prescribed burning alone. The nature of combustion chemistry also presents formidable obstacles. Almost any hydrocarbon up to perhaps 30 or more carbons can imaginably be synthesized during the combustion of wood and foliage. There are also large amounts of nitrogen oxides and carbon dioxide, variable amounts of carbon monoxide, some sulfur oxides and possibly small amounts of complex compounds that may be chlorinated by reaction with biological chloride, induced and powered by the energy of the combustion. There is a variety of complex biological compounds already in wood and foliage that may emerge intact or altered according to their volatility and vulnerability to heat. The pattern of products may vary with oxygen availability and temperature, with species of wood, moisture content, fuel loading and presumably other factors. The third problem is that the biological data describing the various toxicological characteristics of smoke components is limited.

In spite of all these difficulties, there appear to be ways to estimate the impact of at least certain components of smoke on health.

The products of combustion can be categorized into several discrete groups, within which the members can be expected to have reasonably similar biological effects. There will be a great number of low molecular weight hydrocarbons, most of which are produced in small amounts and are relatively innocuous in the context of open combustion. Carbon monoxide from forest burning is unlikely to qualify as a disseminated environmental hazard, but may well be plentiful enough to affect firefighters or other workers at the fire site. Nitrogen oxides similarly have environmental effects, but may not represent a primary health hazard in the direct sense. Eventually attention should be paid to the contribution of slash-derived nitrogen oxides to the pattern of photochemical reactions with other molecules in the atmosphere.

The present analysis is intended to concentrate on the polyaromatic hydrocarbons (PAH), to provide some idea of the extent of risk, primarily cancer risk, that might be expected from movement of these combustion products into populated areas. Unfortunately, while a large number of PAH have been identified as combustion products, only a few have been measured in fires, in a limited spectrum of burning conditions. Enough data are available, however, that reasonable estimates of the amounts of PAH in a smoke plume may be made.

The PAH have been recognized for decades as potential health hazards. Many have been shown to have carcinogenic potential, some have been found to have no carcinogenic or mutagenic activity, and for many others the data is not sufficient to make a judgment. The most common sources of PAH are industrial and power generation burning, internal combustion exhaust, and tobacco smoking, if one considers the personal environment. These primary sources have resulted in finding the chemicals in food, water, organisms at various trophic levels, soil and so on. Formation of PAH from wood combustion was known long ago but became a public concern only in recent times when the contribution of residential wood combustion and forest and agricultural burning to the total PAH burden became recognized.

Cancer is the most important of the irreversible diseases that we must be concerned about, and to judge the carcinogenic impact of the mix of PAH derived from slash burning, we intend to examine the few for which enough data is available on both the amounts produced and their biological effects. Reproductive and other health effects are not being considered at this time. It is expected, however, that reproductive effects at the levels of PAH encountered in even heavy smoke will be found to be highly unlikely, as a general case.

Among the few examples of PAH known to be in wood smoke and which are carcinogenic are benzo(c)phenanthrene, the benzofluoranthenes, 3-methylcholanthrene, dimethylbenzanthracene and benzo(a)pyrene. At least benzo(a)pyrene (BaP) is acknowledged as a human carcinogen. It has also been the most extensively studied of the airborne PAH, and because of the great body of data on its distribution in smoke and in the environment generally, as well as massive amounts of biological data, it serves here as a model compound. While it is not the only carcinogen in smoke, it may have the greatest overall potential for such effect. It is true that there are problems in using BaP as the surrogate for all PAH, and this question has been discussed in detail by Haemisegger et al., of EPA (1985). Nonetheless it provides an approach that I would expect to lead to estimates of risk that are within an order of magnitude of any that will be developed on a more precise basis.

It is not necessary to review the body of research describing the chemical processes that form these substances; for the present purpose it is sufficient to know they are present, and in approximately what amounts. The multitude of works describing the biological behavior of BaP, particularly its genetic and other biological effects also need not be reviewed in detail here. A general description of their biological interaction is set out in Attachment A.

The EPA Cancer Assessment Group (CAG), has derived a potency figure for BaP which can be used in estimating human risk from the calculated exposures. In this report the risk has only been estimated in terms of individuals to whom some defined degree and period of exposure can be assigned. An estimate of increased risk on a regional population basis is not yet included, although EPA and others have carried out similar exercises for exposures to PAH in other kinds of areas.

There is a great deal of data available comparing concentrations of BaP and total PAH in various environments. For the present problem, these are of value primarily as comparisons; for example, BaP concentrations in and around wood-burning homes and communities are discussed later. Santodonato et al. (1980) have attempted to estimate the overall human exposure through all media to BaP, carcinogenic PAH and all PAH. The identified carcinogenic PAH noted in that paper do not include all known carcinogens of the class, but suggest that 10-20% of the total production in the group are carcinogenic to some degree. These are typical of studies directed toward regional or national considerations, and have only limited value when examining singular problems like emissions from slash burning. As yet, specific data on slash burning seems scarce, and hypothetical models are relied upon.

ENVIRONMENTAL BEHAVIOR AND EXPOSURE ESTIMATES

It is generally agreed that the PAH are not free in the atmosphere as vapor and that they are incorporated in fine particulates with diameters well within respirable limits. Ryan and McMahon (1976) indicate that 80-90% are of mass median diameter less than 1.0 µm. Sandberg et al. (1975) found 69% at less than 0.3 µm, and Oregon DEQ estimates that 75% of grass smoke particles are less than 0.5 µm. Pierce and Katz (1975) found somewhat larger particles, but still estimated that up to 80% were below 3 µm, which is small enough to move into the alveolae of the lung. In other words, we must assume that all of the PAH in the atmosphere may have maximal opportunity for contact and absorption.

There are two other reasons why particle entrainment of PAH is important. First, BaP in the pure form, administered by inhalation to experimental animals without the other carbonaceous matter of the particles appears not to be a particularly potent carcinogen, but when administered with carbon particles the potency rises sharply. (Laskin and Sellakumar, 1974; referenced in Friberg and Cedarlof, 1978) Second, while PAH in solution photodegrade, the soot particle (which is partly PAH) apparently protects against photochemical degradation, and for the moment it is necessary to assume a long half-time for at least some atmospheric PAH. Field studies of PAH transport have shown such persistence. (Lunde, 1977) It is not yet clear that slash emissions fit that pattern, but an assumption of persistence must be made.

To judge BaP exposure, there must be some reasonably dependable index of atmospheric BaP concentration available to us. Several relationships are possible. If the output of material from a given amount of fuel is known, we have an estimate of the amount of material that has gone into the atmosphere. Presumably an estimate of fuel loading per acre would tell something about the absolute amount of product formed, but the difficulty is that there is no way of measuring the volume of distribution. Does that smoke occupy one cubic mile or twenty? The fuel and character of the fire are influential, and within that volume, the density will vary with altitude, with topography and with air movement. Technically, it is possible to make direct measurements of BaP or other PAH in the atmosphere. To obtain an accurate picture of regional distribution, however, requires great numbers of samples, a high level of staffing, and experiments with a variety of fire types. The unfavorable economics of such an effort is obvious, but alternative approaches may well be satisfactory.

Because there is some order in the relations between particulate concentration and PAH, between fuel consumed and PAH, and between fuel consumed and particulates produced, it would appear that some combination of those relationships could be used to estimate amounts of PAH in the atmosphere. Of these the most easily observed, either by instruments or by eye, is smoke density which is simply another term for particulate concentration. Smoke measurement is all the more favored because the property of smoke to obstruct or scatter light is reasonably constant. If we can assume that products of combustion follow smoke in a reasonably constant manner, optical observations should therefore be a usable index of the amount of other combustion products present.

A relationship between BaP and particulate matter can be measured directly, as has been done by White et al. (1985), and Ward and Hardy (1984), or indirectly by using data on BaP produced/kg fuel (Table 1). The latter must be coupled to smoke density by measurements of particulate production per kg fuel. Exposures calculated by both methods will be illustrated below.

In Table 1, BaP emission factors for several fuels are shown, in some cases providing information on the effects of different modes of burning of the same fuel. It is evident from these and other data that the mode of burning has great influence on the BaP emission characteristics. A fast burn with little smoldering clearly results in less PAH production. As the amount of green vegetation in the fire increases, PAH increases. (Ward and Hardy, 1984) For the purpose of preparing a very simple risk model, we will use a BaP emission factor of 2,500 µg/kg, which is on the high end of the range shown, and a number that EPA apparently finds sufficiently conservative. (Elmore, 1984) This figure leads to a BaP/particulate ratio that is about an order of magnitude higher than the highest ratio measured directly in the field. Forest managers are aware of factors that diminish emissions from prescribed burning, and more research into this problem is emerging. It is to be expected that outputs of BaP on the high end of the ranges shown in Table 1 are unlikely.

TABLE 1. BaP EMISSION FACTORS

Fuel & Condition	µG BaP/KG Fuel	Reference
Pine	50	Dasch, 1982
Willow	700	Dasch, 1982
Willow	1900	Dasch, 1982
Ash	5	Dasch, 1982
Ash	17	Dasch, 1982
Pine slash, backing fire	238-3454	Ryan & McMahon, 1976
Pine slash, heading	38-97	Ryan & McMahon, 1976
Grass straw	500	Oregon DEQ, undated
Spruce wood, normal 02	50	Ramsdahl, 1982
Spruce wood, 02 starved	620	Ramsdahl, 1982
Charcoal, normal 02	0.3	Ramsdahl, 1982

Particulate emission measurements have ranged from a high of 40 gm/kg fuel to 8.5 gm/kg. (Imhoff, 1983; Dasch, 1982; Sandberg, 1975; Radke, 1978; Lim and Lips, 1981) Most of the ratios fall between 8.5 and 15 gm/kg fuel. If we are to use such numbers to draw a relation between smoke density and BaP concentration in the air in order to estimate human exposure, the lower particulate output per unit fuel implies a high concentration of BaP in the atmosphere if the BaP output/kg fuel remained the same. In our estimates we will therefore use the low figure of 8.5 gm particulate/kg fuel and the relatively high emission factor of 2500 µg BaP/kg fuel. In other words, 8.5 gm of particulate is assumed to be accompanied by 2500 µg BaP. With this relationship, it is unnecessary to know the amount of fuel consumed; it is now only necessary to know the particulate loading in the atmosphere. The most easily used attribute of smoke is the visibility limit, because smoke has a relatively constant ability to obstruct or scatter light. The visibility truly becomes a limit during some intrusions of smoke from field burning, slashburning or even residential wood heating.

The light extinction for smoke is about 0.5 gm/square meter. A square column one meter on each side containing 0.5 gram of smoke would block all light, whether the column was very long or so short the particulates were spread in a layer. If the column is 100 meters long, or about the distance from goal post to goal post on a football field, the volume would be 100 cubic meters and the concentration of particles would be at a concentration of 0.005 gm or 5 mg/cubic meter. The amount of BaP would correspond to the fraction represented by 2500 µg BaP/8.5 grams of particulate, which is 0.294 µg/mg. In our example of 5 mg particulate per cubic meter, this concentration would be about 1.5 µg BaP/5 mg smoke/cubic meter. If we use a larger particle emission factor, the BaP concentration estimate would be inversely lower.

Table 2 shows how dosage may be estimated at various smoke densities or various visibility limits, using BaP as an example. Arbitrary respiratory ventilation rates and body weights are used in such calculations; differences in body weight and activity make only modest differences in estimates of low-dose effects.

The ratio 1.5 µg BaP/5mg particulate is used as noted above. The daily dose total in Table 2 assumes 20 cubic meter respiratory ventilation per day, which may be as much as twice the normal daily rate. The dose per day assumes a 70 kg adult with complete trapping of all inhaled PAH by the lung.

TABLE 2. THE ESTIMATED RELATION BETWEEN VISIBILITY AND BaP CONCENTRATION AT VARIOUS SMOKE DENSITIES

Visibility	Partic/M^3	BaP/M^3	24 hr Dose	Dose/Kg
100 M (0.06 mi)	5.0 mg	1.5 µg	30.0 µg	0.43 µg
1000 M (0.62 mi)	0.5	0.15	3.0	0.043
1609 M (1 mi)	0.31	0.093	1.86	0.027
3218 M (2 mi)	0.155	0.046	0.93	0.013
8045 M (5 mi)	0.062	0.018	0.372	0.0053

The third column showing the concentration of BaP/cubic meter is the information we will use to estimate risk in this case. The EPA CAG has calculated a potency for BaP of 3.3×10^{-3}. This number represents the estimated added risk for continuous exposure to one microgram of BaP per cubic meter of atmosphere continuously over a 70-year lifetime. Assumptions of standard size and respiratory ventilation are used in the CAG calculations. It is customary to calculate cancer risk according to the lifetime dose, which means that the amount of chemical presumed to be taken in is averaged over the lifetime. This is consistent with present understanding of the biology of cancer initiation. If the relationships in Table 2 are correct, lifetime continuous exposure to BaP only in smoke at 1000 meter visibility limit would carry a risk of $(3.3 \times 10^{-3}) \times$ (0.15 µg BaP per cubic meter/1 µg/cubic meter) $= 4.95 \times 10^{-4}$, or about 5 chances in 10,000. (The atmosphere in a typical woodburning home will contain on the order of 0.005 µg BaP/M^3.)

EXPOSURE RELATIVE TO RISK

Because we do not at this time have direct data describing typical exposures to slash or grass smoke intrusions, a hypothetical situation will be set up in which there are 20 days of exposure per year for six hours each day, to smoke at two miles visibility. The relations are all linear and proportional; any adjustment of exposure upward or down can therefore be immediately reflected in the calculated exposure and risk. The remaining assumption is that the exposed individual resides ten years at the site, with the above exposure repeated each year.

The calculation can be quite simple. Twenty days times six hours times ten years is equivalent to fifty 24-hour exposure days at a concentration of 0.046 µg BaP/M^3. There are 25,550 days in 70 years so the average exposure/day is 50/25,550 x 0.046 µg BaP/M^3, which amounts to an effective lifetime concentration of 0.000091 µg BaP/M^3. (Ambient levels of BaP are usually expressed in nanograms/M^3; 0.046 µg is 46 ng, 0.000091 µg is 0.091 ng.)

The risk factor for BaP is 3.3×10^{-3} (0.0033) or an added probability of 3.3 chances in 1,000 of contracting cancer under an exposure of 1 μg/M^3 for 70 years. The risk factor, 0.0033, times the averaged concentration of 0.000091 equals 0.0000003 or a probability of 3 in 10,000,000 (3×10^{-7}). If the particulate/fuel ratio doubled, without increasing the BaP/fuel ratio, the risk would be halved. If the BaP/fuel ratio decreased, the risk would decrease accordingly. Any discussion of risk in this context refers to that in addition to the background probability of cancer inherent in the population, which is on the order of 250,000 cases per million lifetimes. An additional risk of one in one million is considered in the regulatory sense to be the practical equivalent of zero. A risk of 3×10^{-7} is considerably less than the calculated additional cancer risk of living at 5,000 feet altitude instead of sea level, living in a masonry house instead of wood or taking a transcontinental air trip.

To illustrate the difference associated with a changed BaP/particulate ratio, the average ratios between BaP and particulate from slash burning have been estimated in laboratory study by White et al. (1985) at 24 μg/gm, and in the field by Ward et al. (1984) at 15 μg/gm. This may be compared with the indirect relationship of approximately 300 μg/gm used in Table 2 above, (2,500 μg BaP/kg fuel and 8.5 g particulate/kg fuel = 294 μg BaP/gm particulate). It is immediately obvious that the exposures would be vastly less at the same smoke density if the measurements made by White et al. (1985) or Ward et al. (1984) are used. The calculated risks for the hypothetical exposure above would be 12.5 and 20 fold less, respectively, or 1.5×10^{-8} and 2.4×10^{-8}.

TABLE 3. RELATIVE AMOUNTS OF PAH PRODUCED UNDER VARIOUS COMBUSTION CONDITIONS AS μG PAH/GRAM FUEL BURNED, PINE NEEDLES, 18-27% MOISTURE [*a]

	Backing Fires			Heading Fires		
	Fuel Loading, lb/ft^2			Fuel Loading, lb/ft^2		
Chemicals	0.1[*b]	0.3	0.5	0.1	0.3	0.5
benzo(a)pyrene	5.45	0.76	0.27	0.04	0.04	0.1
pyrene	31.7	3.2	1.4	1.12	0.98	1.13
benzo(c)phenanthrene	13.8	1.9	0.62	0.24	0.14	0.175
benzo fluoranthenes	19.2	2.33	1.14	0.16	0.13	0.24
fluoranthene	22.0	2.5	0.84	0.73	0.97	1.05
perylene	3.64	0.25	0.21	0.03	0.02	0.05
benzo(g,h,i)perylene	11.45	1.18	0.63	----	----	----

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[a] Data from Ryan and McMahon, 1976

[b] Equivalent to 2.17, 4.36, and 10.89 tons/acre

Having examined a simple model for estimating added risk associated with BaP, some other PAH for which there are carcinogenicity data and combustion output data can be studied. The first question is how much of these compounds are produced and what factors influence their production. In Table 3, the emissions of several PAH are described for test bed experiments with pine needles. (Ryan and McMahon, 1983) The burns were conducted under backing and heading conditions, at fuel loadings of 0.1, 0.3, and 0.5 pounds per square foot (equivalent to 2.17, 4.36, and 10.89 tons per acre). The reported data is reasonably consistent with that describing emissions from pine slash, presumably whole limbs, et cetera, which produce 0.2-3.4 µg BaP/gram fuel in a backing fire (Ryan and McMahon, 1976).

Aside from the measurements of each PAH, two important pieces of information stand out in the experiments with backing fires. As fuel loading increases, the ratio of PAH produced per unit of fuel decreases sharply. The ratio of PAH/kg fuel at a loading of 0.3 lb/square foot was about 10-14% of the output at 0.1 lb/square foot, and at 0.5 lb the ratio was about 4-6%. Perhaps of greater importance, all of the PAH included in this analysis remained in nearly the same relation to one another at all fuel loadings. This may mean that once baseline information is established, relative concentrations of the various PAH may be predictable from assays of relatively few compounds, under the relatively few sets of conditions. The lower PAH/fuel ratio at higher loadings may be a function of the increased heat generated by the additional fuel. It is well established that higher temperatures decrease PAH output. This may also be the reason for the low output with little difference between loadings in heading fires, which would tend to burn hotter.

The next step in the sample risk analysis is estimation of the relative concentration of the other PAH under consideration at this time. For this exercise the data of Ryan and McMahon arranged in Table 3 are used as a basis for an estimate of the amount of each PAH to be expected in a plume, either related to BaP concentration or to smoke density (Table 4).

Following that information, carcinogenic risks can be estimated for each of the PAH in the discussion, as shown in Table 5. The approach is based on comparison of the limited data available for most PAH with the extensive information on BaP. It is one of the most studied of chemicals and is a classical model for carcinogenesis study. It is also the most extensively measured of the environmental PAH. For the other compounds discussed here, there is a more modest accumulation of environmental data, and at least some carcinogenesis data. Probably none of these substances is will enough documented to be analyzed independently. Furthermore, few have been studied under inhalation exposure conditions, as BaP has.

Those that have been evaluated for carcinogenicity have been studied in the topical application skin tumor initiation-promotion model, which by itself is not necessarily helpful if we are concerned about lung cancer due to pulmonary contact. The estimates of risk for the various PAH in Table 5 are therefore based on an assumption that the pulmonary carcinogenic sensitivity to a given PAH relates to that of BaP in the same way as do their respective sensitivities to skin tumor initiation. The data for comparison can only be considered semiquantitative, and they are categorized in relative orders of magnitude compared with BaP.

The EPA-CAG estimated potency of 3.3×10^{-3} for BaP is equaled by one compound, one is estimated to have 10% of the potency of BaP, two others are characterized by ambiguous data and are arbitrarily assigned a potency of 10% of that of BaP, and two others have no observable potency, according

TABLE 4. CONCENTRATION OF PAH AT VARIOUS ATMOSPHERIC PARTICULATE (SMOKE) LOADINGS IN µG/M^3
Column A assumes 300 µg BaP/mg particulate,[a] Column B assumes 24 µg/mg[b]

Visibility Limit	100 M (0.06m)		1000 M (0.62 mi)		1609 M (1 mi)		3218 M (2.0 mi)		8045 M (5.0 mi)	
Particulate/M^3	5 mg		0.5 mg		0.31 mg		0.155 mg		0.062 mg	
	A	B	A	B	A	B	A	B	A	B
benzo(a)pyrene	1.5	0.12	0.15	0.012	0.093	0.007	0.046	0.004	0.018	0.001
pyrene	[c] 8.69	0.69	0.87	0.07	0.54	0.043	0.27	0.021	0.108	0.009
benzo(c)phenanthrene	3.80	0.3	0.38	0.03	0.24	0.019	0.12	0.01	0.148	0.004
benzo fluoranthenes	0.52	0.042	0.052	0.0042	0.032	0.002	0.016	0.001	0.006	0.0003
fluoranthene	6.05	0.48	0.6	0.05	0.37	0.03	0.18	0.014	0.074	0.006
perylene	1.0	0.08	0.1	0.008	0.06	0.005	0.031	0.002	0.012	0.001
benzo(g,h,i)perylene	3.15	0.25	0.3	0.025	0.19	0.015	0.096	0.008	0.038	0.003

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[a] 300 µg BaP/mg particulate based on assumption of 2500 µg BaP/kg fuel and 8.5 g particulate/kg.

[b] 24 µg/mg particulate based on direct measurement by White et al., (1985).

[c] Concentrations of all PAH calculated from relative concentrations at 0.1 lb./ft^2 fuel loading in Table 3.

TABLE 5. RISK ASSOCIATED WITH VARIOUS PAH AT SMOKE DENSITY CHARACTERIZED BY TWO-MILE VISIBILITY, ASSUMING 20 SIX-HOUR EXPOSURE DAYS/YR OVER 10 YEARS OF RESIDENCE, NORMALIZED TO CONTINUOUS AVERAGE EXPOSURE OVER A 70-YR LIFETIME [a] [b]

Chemical	Potency [c]	Concentration $\mu g/M^3$	Concentration norm to 70 yr $\mu g/M^3$	Risk if [f] BaP-300μg/mg Particulate	Risk if BaP-24μg/mg Particulate
benzo(a)pyrene	3.3×10^{-3}	0.046	0.00009	3.0×10^{-7}	2.4×10^{-8}
pyrene	0	0.27	0.00053	---	---
benzo(c)phenanthrene	3.3×10^{-3} [d]	0.12	0.00023	7.6×10^{-7}	6.1×10^{-8}
benzo fluoranthenes	3.3×10^{-4} [d]	0.016	0.000031	1.0×10^{-8}	8.0×10^{-10}
fluoranthene	0	0.18	0.00035	---	---
perylene	3.3×10^{-4} [e]	0.031	0.000061	2.0×10^{-8}	5.0×10^{-9}
benzo(g,h,i)perylene	3.3×10^{-4} [e]	0.096	0.00019	6.27×10^{-8}	5.0×10^{-9}
		TOTAL RISK [g]		1.1×10^{-6}	8.8×10^{-8}

[a] Visibility is related to particulate density by use of extinction factor of 0.5 g particulate/square meter, see text p. 10.

[b] A constant ratio of BaP to other PAH as indicated in Table 3 at 0.1 lb/ft^2 fuel loading is assumed.

[c] Potency is the estimated probability of cancer resulting from 70 years inhalation exposure to 1 $\mu g/M^3$.

[d] Potency is estimated by comparison of skin painting data for PAH in IARC monograph 32, 1983, with data from similar experiments with benzo(a)pyrene, and assuming that pulmonary carcinogenic potency will bear a similar relation to potency of 3.3×10^{-3} for BaP estimated by EPA-CAG.

[e] Where evidence is insufficient to determine whether a compound is/is not carcinogenic, potency is assumed as 10% of BaP potency.

[f] 300 μg BaP/mg particulate based on assumption of 2500 μg BaP/kg fuel; 8.5 g particulate based on direct measurement by White et al., 1985.

[g] Total risk is assumed to be sum of risks ascribed to individual PAH.

to IARC (1983). With that information, a series of risk estimates for the individual PAH at various smoke densities is listed, for two different ratios of BaP to particulate matter.

It is of interest to compare these estimates of projected exposure to slash smoke components with data on sources of wood smoke that have been obtained in other settings. The problem of PAH health effects has been known for many years, and the decade from 1966 to 1975 saw a major downturn in the amount of such material in the atmosphere, particularly in urban centers, which in some cases have reduced ambient levels to 0.2-0.4 ng BaP/M^3. Many cities still range up to 2 ng/M^3, however. Urban areas that derive a significant fraction of heating from wood have higher levels. Measurements have been made in several small U.S. communities that derive most of their heat from wood. Three villages in New Hampshire were found to have average concentrations of 0.4-0.5 ng/M^3 (Hornig et al., 1981). In Mio, Michigan, concentrations ranged between 1.1 and 13.8 ng/M^3, with one very high value of 42.7 ng/M^3 (Engel, 1985) and in Telluride, Colorado, Murphy et al. (1984) found a mean level of 7.2 ng/M^3. In both cases BaP was found to arise primarily from wood fuel. Other communities were less burdened, perhaps because of meteorological differences. In an upper middleclass subdivision BaP levels were between 1.5 and 2.5 ng/M^3 with higher surges on weekends, most of which was from wood (Imhoff et al., 1983). In Waterbury, Vermont, the mean concentrations were below 1 ng/M^3(Sexton et al., 1985). Air from northern Norway contained only 0.06 ng/M^3 (Lunde, 1977).

Indoor concentrations in wood-burning homes are sometimes very high, reaching as much as 8 ng/M^3, according to Moschandreas, 1980, as quoted by the same author in a later 1981 paper.

The risks associated with residential wood combustion may be estimated in the same way we estimated risks associated with slash burning. It is fair to assume that in western Oregon a fire would be maintained during six months of the year, and if the fire is banked at night, PAH output would increase because of decreased oxygen supply. If a fire is allowed to go out there would be a six- to eight-hour period of decreased output. For this analysis the concentration is assumed to remain constant through the burning months.

An environmental BaP concentration of 1 to 4 ng/cubic meter in the vicinity of a wood-burning rural home is probably representative, recognizing that much higher levels often occur. It may be argued that as residential density decreases, the environmental air loading would decrease.

Interior levels would be relatively unaffected by residential density. Let us assume steady state loadings of 1 to 4 ng/M^3, representing the range to be found both outdoors and inside a wood-burning residence for six months of the year. Unless a stove is very well made, levels may be much higher. The effective period of exposure for six months a year over ten years of residence is 1,825 days. 1,825 days/25,550 days (days in 70 years) gives a factor of 0.0714 which normalizes to the average daily exposure over a lifetime. The ten-year by six-month exposures normalized to a lifetime for 1 ng BaP/M^3 is 0.000071 µg/M^3.

The risk associated with this exposure or its multiples can be related to the added unit risk defined by the EPA Cancer Assessment Group of 3.3×10^{-3} for continuous intake of one microgram/cubic meter. Exposure to one nanogram is a thousandfold lower and would be 3.3×10^{-6} or three chances in one million. Ten ng/M^3 would carry a risk ten times higher.

Assuming the same pattern of PAH production, the total risk associated with firewood burning for the series of PAH we are considering at the moment, at concentrations of 1, 2, 3, and 4 ng BaP/M^3 would be 0.847, 1.7, 2.5, and 3.3×10^{-6}, respectively. The last factor would represent 3.3 chances in a million. If lifetime rather than 10-year exposure is to be considered, each of these factors would be raised by sevenfold.

It appears that the relative risk of ordinary wood burning is at least as high as the risk calculated using the extremely conservative assumptions upon which the figures shown earlier are based. Given the very high concentrations found in some homes, some individuals are probably at risks on the order of one to ten chances/100,000.

It is questionable whether the rather severe exposure sequence assumed for slash smoke would ever occur. However, it will be used until additional specific data on smoke intrusions are incorporated into the analysis. Also, there may be specific locations in which unusually high exposures might occur to a few specific individuals. In view of the known fuel consumption (10-30 tons/acre) in most slash burns, the assumed conversions of fuel to PAH are unrealistically high, and it is likely that the measurements of Ward & Hardy (1984) and White et al. (1985) do reflect more correctly the BaP/particulate ratio in the field.

There seems to be a consensus that for the present BaP is an adequate surrogate for other PAH, since it is perhaps the most important factor. It is at least as potent as any of the other chemicals, and its chemistry and biological impact are known in great detail. In fact it serves as a positive reference in studies of other PAH.

There is a particular problem in dealing with some of the other potential carcinogens in the PAH fraction because there is far less data on either biological effects or physical presence than exists for BaP. At the same time, the estimates made for BaP incorporate exceedingly conservative assumptions of exposure, and it will not be surprising if the risk is overestimated by orders of magnitude. It is doubtful whether the other carcinogenic components of smoke will account for more than a doubling or tripling of the estimated risk from BaP to individuals under the circumstances described, and the population at risk will be found to be vastly less than that.

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ATTACHMENT

A SKETCH OF THE MECHANISM BY WHICH PAH MAY CAUSE CANCER

It is useful to briefly review the biological interactions of the PAH. Like many complex molecules that are carcinogenic at some dose, the PAH are essentially nonreactive as they enter the body. Their activity is conferred by the same sequence of metabolic reactions that is intended to detoxify them, as will be seen below. This family of compounds is usually non-polar and lacking any functional groups that can be ionized, and therefore is lipid soluble. Such a character allows ready movement across cell membranes, and results in distribution throughout a variety of tissues, including the fetus. The same characteristics cause the material to be resorbed from the kidney tubules into the circulation. The net result of all this is that the material would be very slowly excreted unless changed in some manner.

In all complex organisms systems have evolved to deal with this problem. In the liver particularly, and to lesser extent in most other tissues are enzyme systems that metabolize such compounds to polar, more water soluble products that can be excreted in the urine or bile. This evolutionary development was in response to natural compounds that must be dealt with by all organisms, and applies itself to the various synthetic materials that humans make as well. Certainly, the substances we are concerned with in this report must be considered natural materials, and have probably been in the environment long before complex organisms arrived.

The sequences of reactions are generally divided into "phase I" and "phase II" activities. In phase I, reactions of oxidation, reduction or hydrolysis either add or expose functional groups, usually oxygen or hydroxyls. These alone improve solubility and will result in some increased excretion. Phase II reactions are conjugative, adding soluble groups such as sulfate, or glucuronic acid to the molecule and further expediting excretion.

There is, however, a problem in all this. The process of oxidation or hydrolysis involves several steps, and includes formation of highly reactive intermediate molecules with two adjacent carbons linked also to a single oxygen (epoxide). The subsequent step is formation of diols, with hydroxyls and adjacent carbons. There has been an enormous body of research on this chemistry, and it is quite clear that the principal ultimate carcinogen is the diol intermediate. If these products are not passed forward through the remaining reactions which render them innocuous, they may "escape" within the cell or migrate to other cells. If they interact with DNA, they may cause damage that may result in initiation of cancer or mutation. Almost all carcinogens are activated in this fashion. Because cancer is a self-proliferating disease, it is at least possible that a single initiated cell could give rise to a cancer.

It is probable that escape from the intended reaction scheme is dependent on the concentration of intermediates in the cell, but it has by no means been established at what low concentration the reactions do not take place, or at which they are so efficient that no escape occurs. This is one among the many reasons why it is not yet possible to determine whether a threshold for cancer initiation exists.

The enzymes responsible for these activities are present at low levels at all times, and when an organism encounters significant amounts of such chemicals the amount of enzyme available increases, or is "induced." The greatest activity is usually in the liver, as is the greatest capacity for induction, but some activity is detectable in most tissues, including the skin. There is a large number of different enzymes that participate in the processes of metabolizing chemicals, but all are linked to perform a relatively few kinds of reactions. There is no need to devise a new enzyme for each new foreign chemical that arrives, because the actions of the enzymes are on a relatively limited number of chemical bonds that are common to all structures.

The metabolic process as it applies to the PAH is very well described in the IARC monograph 32 (1983), in the introductory general remarks.

APPENDIX H

HUMAN HEALTH RISK ASSESSMENT OF THE USE OF HERBICIDES IN THE VEGETATION MANAGEMENT PROGRAM

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Section 1

INTRODUCTION

PURPOSE

The purpose of this analysis is to assess the risk to human health of using 16 different herbicides for vegetation management on Bureau of Land Management (BLM) lands in California.

OVERVIEW OF THE RISK ASSESSMENT

This risk assessment examines the potential health effects on all persons who might be exposed to any of the 16 herbicides as a result of activities related to the vegetation management programs. People potentially at risk are separated into two categories. The first group--workers--includes applicators, supervisors, and other personnel directly involved in the application of herbicides. The second group--the public--includes forest visitors or nearby residents who could be exposed through the drift of herbicide spray droplets, through contact with sprayed vegetation, or by eating vegetation (such as berries), game, or fish containing herbicide residues or drinking water that contains such residues.

The analysis of the potential human health effects of the use of chemical herbicides for BLM's management of vegetation was accomplished using the methodology of risk assessment generally accepted by the scientific community. In essence, pesticide risk assessment consists of comparing doses people may get from applying the pesticides (worker doses) or from being near an application site (public doses) with doses shown to be safe in animal laboratory studies.

A number of factors contribute to the uncertainty in this process of judging risks to human health from laboratory animal studies. First, the safe levels established in the laboratory are the result of tests on laboratory animals, particularly rats and mice, where dose levels produce no observed effects. To allow for the uncertainty in extrapolating from these no-observed-effect levels (NOELs) in lab animals to safe levels for humans, additional safety factors are used. The generally accepted factors (NRC 1986) are 10 for moving from animals to humans (between species variation) and another 10 to account for possible variation in human responses (within species variation). This 10 times 10 or 100-fold safety factor means the laboratory NOEL dose reduced one hundred fold would normally be considered a safe dose. In this risk assessment a margin-of-safety (MOS) has been calculated for each estimated dose by dividing the animal NOEL by the estimated dose. The computed MOS is then compared to the 100-fold safety factor to judge the risks of toxic effects.

A second area of uncertainty is in judging the risk to humans of doses that may be received once or perhaps a few times in a person's life (accidental worker doses and all doses to the public fall in this category) by comparing those human doses to levels of the chemical that produced no ill effects in laboratory animals even though the animals received the doses every day of their lives. This risk assessment uses the MOS approach discussed above in comparing one-time human doses to lifetime animal doses in all of these cases even though this leads to an exaggeration of the risks.

A different approach is used to assess the risks to humans of chemicals that may cause cancer since they are assumed to have no comparable margin of safety so that there is some risk even at extremely low doses. In this case a cancer potency value, expressing the probability of developing tumors at increasing dose levels, is taken from lab animal studies and adjusted for the differences in body weight and lifetime duration between the lab animals and humans. This potency times an estimated human lifetime dose provides an estimate of human cancer risk.

A third area of uncertainty involves the estimation of the human doses liable to occur in herbicide use. This risk assessment has been designed to overestimate doses to err on the side of safety. In reality, workers are likely to receive some low level doses because they work with the chemicals routinely. However, standard safety practices and the use of protective clothing will normally reduce their actual dose levels far below those estimated in this analysis. The same is true of the doses from any spraying or spill accidents that might occur, since the normal procedure would be to wash immediately. In addition, no member of the public is likely to receive as high a dose as estimated in this risk assessment; again because normal safety practice and the remoteness of most treated areas limit the possibility of the public receiving any dose at all. Furthermore, the public doses estimated here exaggerate the amount they could receive. No herbicide degradation is assumed to occur, the public is not assumed to wash themselves or their food items after a spraying, and they are assumed to consume water that has received herbicide from drift or a spill immediately after the event. Thus, the way in which exposures are estimated in this risk assessment and the way the risks are judged both tend to exaggerate the real risks.

The risk assessment includes analyses of a range of possible exposures-from realistic to worst case--resulting from herbicide application. Typical application scenarios (routine-realistic) are used to estimate the doses to workers and to members of the public who may be nearby that may reasonably be expected to occur during routine operations. Extreme application scenarios (routine-worst case) are used to give very high dose estimates that are not likely to be exceeded except in the case of an accident. Accident scenarios (accidental-worst case) are used to estimate doses to workers and the public that may result from direct exposure to the herbicide spray mix or concentrate or from drinking water into which a truckload of herbicide mixture or a drum of herbicide concentrate has been spilled.

Structure of the Risk Assessment

This risk assessment employs the three principal analytical elements described by the National Research Council (1983) as necessary to characterize the potential adverse health effects of human exposures to existing or introduced hazards in the environment: hazard analysis, exposure analysis, and risk analysis.

1. **Hazard Analysis** requires gathering information that is used to determine the toxic properties of each herbicide. Human hazard levels are derived primarily from the results of laboratory experiments on animal models, such as rats, mice, and rabbits, supplemented where appropriate with information on human poisoning incidents, field studies of other organisms, and data on chemical structure.

2. **Exposure Analysis** involves estimating single and multiple exposures to persons potentially exposed to the herbicides, determining the doses likely to result from those estimated exposures, and determining the number and characteristics of persons in the exposed populations.

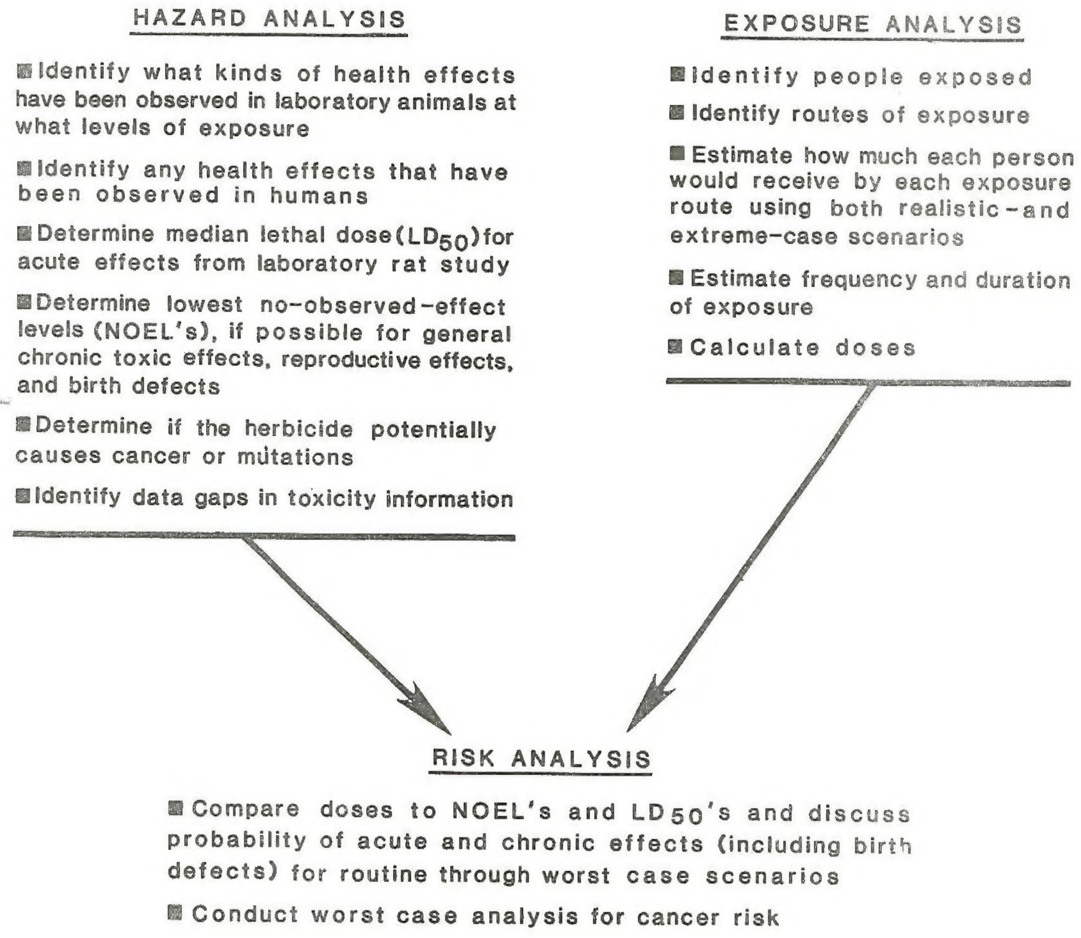
3. **Risk Analysis** requires comparing the hazard information with the dose estimates and the probability that they could occur to predict the health effects to individuals under the given conditions of exposure.

The relationships among these three components are illustrated in Figure H-1. This risk assessment identifies uncertainties, such as areas where scientific studies are unavailable, and presents the results of all worst-case analyses. The discussion that follows describes briefly how each component in the structure was addressed in this risk assessment.

Hazard Analysis

The 16 herbicides being considered for vegetation management programs are amitrole, asulam, atrazine, bromacil, 2,4-D, 2,4-DP (dichlorprop), dalapon, dicamba, diuron, fosamine, glyphosate, hexazinone, picloram, simazine, tebuthiuron, and triclopyr. The hazard involved in the use of each of the herbicides was determined in a thorough review of available toxicological studies. Where no studies have been conducted in a particular area, for example, mutagenicity, these areas are identified and a worst-case analysis is conducted in Section 4. Scientific uncertainty regarding the results of these studies, for example, concerning the results of the cancer studies on glyphosate and 2,4-D, is also discussed. The hazard analysis is discussed in Section 2.

The toxicological data base for each herbicide was reviewed for acute and chronic effects on test animals. Toxicity information is summarized for 12 of the 16 herbicides in the background statements of Forest Service Agricultural Handbook No. 633 (USDA, 1984). Tebuthiuron toxicity is reviewed in a background statement prepared for the Forest Service as a supplement to Handbook No. 633. Toxicity information is summarized for the herbicides asulam, diuron, and bromacil in background statements written in conjunction with this risk assessment. These documents are incorporated by reference into this Supplement in accordance with 40 CFR 1502.21 and are available for review at the BLM California State Office.



HAZARD ANALYSIS

- Identify what kinds of health effects have been observed in laboratory animals at what levels of exposure
- Identify any health effects that have been observed in humans
- Determine median lethal dose(LD_{50})for acute effects from laboratory rat study
- Determine lowest no-observed-effect levels (NOEL's), if possible for general chronic toxic effects, reproductive effects, and birth defects
- Determine if the herbicide potentially causes cancer or mutations
- Identify data gaps in toxicity information

EXPOSURE ANALYSIS

- Identify people exposed
- Identify routes of exposure
- Estimate how much each person would receive by each exposure route using both realistic-and extreme-case scenarios
- Estimate frequency and duration of exposure
- Calculate doses

RISK ANALYSIS

- Compare doses to NOEL's and LD_{50}'s and discuss probability of acute and chronic effects (including birth defects) for routine through worst case scenarios
- Conduct worst case analysis for cancer risk

Figure H-1 Components of the Risk Assessment Process

Exposure Analysis

To estimate the potential human exposures to the 16 herbicides, the various aspects of the vegetation management programs of the Bureau of Land Management in California that employ herbicides to control vegetation were examined. The major aspects of the vegetation management programs that determine the potential levels of herbicide exposure were identified, including human activities associated with or in proximity to treatment areas, application methods, application rate, size and configuration of spray areas, project design features, and mitigation measures.

Herbicide Spraying Operations

The 16 herbicides examined in this risk assessment are applied aerially, using fixed-wing or helicopter aircraft, or on the ground, using trucks or tractors, backpack sprayers, or handheld application devices. Table 1-3 shows the types of operations where the herbicides are used and the approximate yearly acres. The cumulative analysis makes the worst-case assumption that 100,000 acres are treated each year as a result of the combined programs. The size of the program and the mix of activities may vary in any given year as described in the EIS.

These annual programs would involve a limited number of large projects and many small projects ranging from one to many separate treatment units. Individual silviculture treatment units within a project typically range from 15 to 60 acres. A number of individual sites are normally treated at one time, with 120 to 150 acres normally treated per day. Occasionally there are treatment areas much smaller (less than 1 acre) or much larger (up to 200 acres), especially for noxious weed control projects. Treatment units for range management projects are generally larger, with 200 to 400 acres normally treated each day.

Affected Populations

In calculating the potential doses to persons at risk from herbicide applications, two populations were considered: workers and the general public. The workers included the personnel directly involved in the spray operations: the mixers and loaders, the truck-sprayer applicators and drivers, the backpack sprayers, the hand applicators, the pilots, the observers, and the supervisors. The public included public land visitors and nearby residents who may be directly exposed to herbicide as a result of drift, by contact with vegetation that has received herbicide drift, or by being accidentally sprayed. The public may be indirectly exposed by eating food items or drinking water containing herbicide residues.

Routine Exposure Scenarios

This risk assessment examines the health effects of exposure to an individual herbicide treatment as well as the cumulative effects of exposure over a number of years. To represent the range of doses under normal operating procedures, eight application scenarios were used. Under the routine-realistic scenario, four application methods, employing normal herbicide application rates and typical treatment unit sizes, were used to calculate realistic doses to workers. Doses to members of the public who may be in the area or who may live nearby were calculated for aerial, truck, and backpack scenarios. No public exposures were expected from hand-application treatments because drift is negligible from these methods.

Four additional scenarios, using the same application methods as routine-realistic but employing the highest application rates likely to be used and the largest treatment unit sizes under conditions conducive to offsite herbicide drift, were used to estimate routine-worst case doses to workers and the public. These dose estimates purposely overestimate doses expected from routine applications.

Cumulative doses were estimated by using information on average and maximum treatment days per year and on average and maximum number of years exposed for workers and for the public.

Accident Exposure Scenarios

Because all human activities involve the possibility of error, the use of herbicides in vegetation management involves the possibility that humans may inadvertently receive unusually high exposures to the herbicides because of accidents.

To examine what potential health effects could occur in an accidental situation, a number of accidental-worst case scenarios are analyzed. Exposures analyzed include direct aerial application of herbicide on a person, spills of concentrate or herbicide mix on workers in mixing and loading, and spills of herbicide into drinking water supplies. One accidental scenario assumes that a person enters a treated area (ignoring warning signs) before any herbicide has dried or degraded.

The probabilities of these accidental scenarios range from unlikely to extremely unlikely. Wherever possible, historical records of accidents were used in determining the probabilities of accident occurrence.

Dose Estimation

Estimates of routine doses to workers were derived from field studies on the five herbicides (2,4-D, 2-4-DP, dicamba, amitrole, and picloram) for which that information is available. Where no studies existed on a particular herbicide, doses were extrapolated from a 2,4-D worker exposure study that used the same application method.

Worker exposures to each herbicide were based on the worker's task, for example, backpack sprayer, pilot, mixer-loader, and so forth, rather than the type of vegetation management project because the same equipment and procedures are often used in these operations. The exposures between operation types are weighted by application rate and number of hours worked per day. Where the exposure of a worker in a particular task, such as mixer-loader, is significantly different from one project type to another, that exposure is determined separately for each representative operation.

Exposures and doses to members of the general public were derived by using data on herbicide drift from field studies and by applying various assumptions about dermal penetration, amount of skin exposed, and diet. Details of the exposure analysis are given in Section 3.

Risk Analysis

Human health risks of the vegetation management program were evaluated by comparing the doses of workers and the general public calculated for routine operational and accidental exposure scenarios to the laboratory-determined toxicity levels described in the hazard analysis.

Risk of acute and chronic threshold effects is evaluated by comparing estimated doses to toxicity reference levels derived from LD_{50}s and NOELs (no-observed-effect levels) in laboratory animal studies, and a margin of safety (MOS) is derived. Risk increases as the estimated dose approaches the laboratory toxicity level.

Nonthreshold risk, that is, the potential for these herbicides to cause cancer and mutations, was evaluated differently. The analysis showed that currently there is scientific uncertainty regarding the potential of eight of the herbicides--amitrole, asulam, atrazine, bromacil, picloram, 2,4-D, 2,4-DP, and glyphosate--to cause cancer in humans. Therefore, this risk analysis uses the worst-case assumption that these eight herbicides would cause cancer in exposed persons. The risk of cancer at a given level of exposure, based on the estimated average daily exposure over a 70-year lifetime, was derived for the herbicide in question from laboratory animal data on tumor incidence at increasing dose levels. These data were corrected for species differences, body size difference, dose frequency, and duration of exposure; and the risk of cancer was calculated for various categories of people that may be exposed to the herbicides.

The risks of heritable mutations are discussed based on available test data on bacteria, yeasts, plants, mammalian cells in culture, and whole animals. Where no test data are available, a worst-case assumption is made that these herbicides are mutagenic and that risk is compared to the herbicide's cancer risk.

Cumulative risk for individuals is discussed in terms of lifetime exposures to a given herbicide for workers and for members of the public. Risk of synergistic effects is discussed in terms of the available evidence of enhanced toxicity in mixtures of two or more herbicides. Risk to sensitive individuals is discussed qualitatively in terms of the likelihood of a sensitive individual being exposed.

WORST-CASE ANALYSIS REQUIREMENTS

This document has been prepared pursuant to the requirements of the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ) regulations for implementing NEPA. The CEQ regulations (40 CFR 1502.22) state:

> When an agency is evaluating significant adverse effects on the human environment in an environmental impact statement and there are gaps in relevant information or scientific uncertainty, the agency shall always make clear that such information is lacking or that uncertainty exists.
>
> (a) If the information relevant to adverse impacts is essential to a reasoned choice among alternatives and is not known and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement.
>
> (b) If (1) the information relevant to adverse impacts is essential to a reasoned choice among alternatives and is not known and the overall costs of obtaining it are exorbitant or (2) the information relevant to adverse impacts is important to the decision and the means to obtain it are not known (e.g., the means of obtaining it are beyond the state of the art) the agency shall weigh the need for the action against the risk and severity of possible adverse impacts were the action to proceed in the face of uncertainty. If the agency proceeds, it shall include a worst-case analysis and an indication of the probability or improbability of its occurrence.

This risk assessment identifies a number of uncertainties or data gaps, including the following:

1. Field studies on exposure to workers for all of the herbicides except 2,4-D, 2,4-DP, dicamba, amitrole, and picloram.
2. Information on exposure of the public to the 16 herbicides.
3. Field data on residue levels in plants and animals most likely to be found in and around treatment areas for some of the herbicides.
4. Mutagenicity studies for bromacil, dalapon, and diuron.
5. The potential for amitrole, atrazine, asulam, bromacil, 2,4-D, 2,4-DP, picloram, and glyphosate to cause cancer.
6. Toxicity information on the synergistic effects from exposure to more than one herbicide.

These areas of uncertainty are important in deciding what is the best alternative for action; however, the cost of obtaining this information is an important consideration. From discussions with the Environmental Protection Agency, the Department of Agriculture, the Department of the Interior, and the chemical manufacturers, it is estimated that the costs per chemical of conducting some of the standard laboratory toxicity tests would be \$1.5 to \$2.0 million for a chronic toxicity study with rats and dogs; \$1.5 to \$2.5 million for an oncogenicity test with rats and mice; and \$50,000 to \$100,000 for each mutagenicity and chromosomal study.

Table H-1
Data Gaps Identified in Risk Assessment for Herbicides

DATA GAPS	HERBICIDE*											
	Amitrole[1,2]	Atrazine[3]	Bromacil[4,5]	Dicamba[6,7]	Diuron[8,9]	Hexazinone[10]	Picloram[11]	Simazine[12]	Asulam**,[13,14]	Glyphosate**[15]	2,4-DP**[16]	2,4-D
Product Chemistry												
Product Identify	X	X	X		X	X	X	X				
Analysis and Certification of Product Ingredients	X	X	X	X	X	X	X	X				
Physical and Chemical Characteristics	X	X	X		X	X		X				
Environmental Fate												
Degradation	X	X	X	X	X		X	X				
Metabolism	X	X	X	X	X	X	X	X				
Mobility	X	X	X	X	X	X	X	X				
Dissipation	X	X	X	X	X	X	X	X				
Accumulation	X	X	X	X	X		X	X				
Residue Chemistry												
Nature of Residue							X	X				
Residue Analytical Method		X					X					
Storage Stability				X	X		X	X				
Magnitude of Residue		X		X	X		X	X				
Toxicity												
Acute	X				X	X	X	X	X	X	X	
Subchronic	X			X						X	X	
Chronic	X	X	X	X	X		X	X	X	X	X	
Oncogenic			X	X	X		X	X		X		X
Teratogenic	X	X	X		X		X	X				
Mutagenic		X		X	X		X	X				
General Metabolism		X			X	X	X	X		X	X	
Ecological Effects												
Avian	X		X	X			X	X				
Aquatic	X		X	X	X		X					
Mammalian												
Nontarget Insects												
Spray Drift***							X					
Plant Protection***												
Nontarget Area Phytotoxicity							X					

*Information not available to determine data gaps for Dalapon, Fosamine, Tebuthiuron, and Triclopyr.
**Information not available to determine data gaps other than toxicological for Asulam, and 2,4-DP.
***These issues were addressed for Picloram only.

Sources:
[1]EPA, 1983c
[2]EPA, 1984t
[3]EPA, 1983d
[4]EPA, 1985f
[5]EPA, 1982d
[6]EPA, 1983g
[7]EPA, 1983e
[8]EPA, 1983h
[9]EPA, 1983f
[10]EPA, 1982e
[11]EPA, 1985g
[12]EPA, 1982c
[13]EPA, 1983
[14]EPA, 1984u
[15]EPA, 1985h
[16]EPA, 1982b

The estimated costs to fill the specific data gaps listed above are:

1. Worker exposure studies would cost approximately $200,000 per chemical.
2. No acceptable protocol is available for measuring all of the various routes of exposure of the public, but these studies would be more expensive than the worker exposure studies.
3. The cost of measuring residues in plants and animals would be between $50,000 and $100,000 per chemical per plant or animal.
4. The mutagenicity and chromosomal studies for bromacil, dalapon, and diuron would cost approximately $450,000.
5. The five oncogenicity studies for amitrole, asulam, bromacil, 2,4-D, 2,4-DP, picloram, and glyphosate would cost approximately $11.2 million.
6. Synergistic studies would be extremely expensive because of the great number of tests that would be necessary; there are 120 combinations of the 16 herbicides if studied two at a time.

The overall cost of conducting the studies to fill the data gaps is considered exorbitant with respect to the limited funds available to the BLM. In addition, the time needed to perform and evaluate most of these tests is more than 2 years and would seriously delay the implementation of the vegetation management programs. Many of the outstanding toxicological studies have already been requested by EPA, and the results of these studies will be considered when they become available. In addition, BLM has ongoing research and monitoring programs to examine the various aspects of herbicide treatment, and these results will be considered as they become available.

Because the cost of filling the data gaps is considered exorbitant, a worst-case analysis was conducted for those areas where information is not available or when there is uncertainty. The probability of a worst case occurring was also estimated. The worst-case analyses for the first three uncertainties listed above involved estimating the upper limit of herbicide exposure from routine application procedures and from accidents. The worst-case scenarios involving routine herbicide application operations consist of those combinations of parameters, such as treatment unit size, duration of exposure, application rate, application equipment, and meteorological conditions, that give the highest reasonable exposure value. Worst-case accidents include direct spills of concentrate on workers' skin, the direct spraying of an individual, and public exposure through drinking water contaminated by a spill.

The worst-case analysis for the mutagenicity of chemicals for which there are no data or where there is some positive testing for mutagenicity assumed that all these herbicides could cause mutations. The probability of mutagenic activity was based on available cancer data. The worst-case analysis for herbicides that had either positive cancer studies or for which there is scientific uncertainty assumed that these chemicals could cause cancer. The most conservative cancer potency value for a chemical was computed by using the highest rates of tumor formation found in the available animal studies. The most conservative model for predicting cancer rates was also used. The worst-case analysis for synergistic effects assumed that these effects could occur. The probability of these effects occurring was considered low.

EPA has identified the data gaps shown in Table H-1 in accordance with the registration guidelines under the Federal Insecticide, Fungicide, and Rodenticide Act. Although there are data gaps or areas of uncertainty for some of the herbicides in this risk assessment, there is a large body of existing data that is useful in predicting the behavior and toxicity of these herbicides. These studies include the following:

1. Worker exposure studies with 2,4-D, 2,4-DP, dicamba, amitrole, and picloram.

2. Studies on drift of 2,4-D and glyphosate.

3. Residue information for a number of the herbicides in plant and animal tissues.

4. Cancer studies for those herbicides without mutagenicity studies.

5. Chronic feeding studies that provide some evidence of cancer.

6. Studies either not reviewed by EPA, or validated studies reviewed by EPA, but determined not to be adequate to meet current registration standards, which nonetheless provide some information on toxic effects.

ORGANIZATION OF THIS SUPPLEMENT

Section 1 presents the purpose, describes the structure, and outlines the methodology of the risk assessment. Section 2, the hazard analysis, summarizes and discusses the toxic properties of each herbicide, including the cancer potency of the known or suspected carcinogenic herbicides. Section 3, the exposure analysis, describes the methods used to estimate levels of exposure and resultant doses to workers and the public and presents summary tables and discussions of estimated acute and long-term doses. Section 4, the risk analysis, presents the comparison of the results of the exposure analysis with the toxic effect levels set forth in Section 2. Section 4 also discusses cancer risk, given estimated lifetime doses to workers and the public. Attachment A presents the details of the mutagenicity and cancer testing done on many of the herbicides. Attachment B provides the complete dose estimates for workers and the public derived from the methods described in the exposure analysis. Attachment C presents the complete margin-of-safety tables used in the risk analysis.

Section 2

HAZARD ANALYSIS

INTRODUCTION

This section presents the results of the hazard analysis: a review of available toxicological information on the 16 herbicides--amitrole, asulam, atrazine, bromacil, 2,4-D, 2,4-DP, dalapon, dicamba, diuron, fosamine, glyphosate, hexazinone, picloram, simazine, tebuthiuron, and triclopyr--that are to be used in BLM vegetation management programs in California. The first subsection describes the sources of toxicity information used in the hazard analysis. The second subsection explains the terminology concerning laboratory toxicity testing used later in describing the toxic properties of the 16 herbicides. The third subsection presents summaries of the threshold toxicity of each herbicide drawn from the information that was available. The fourth and fifth subsections describe the potential for each of the 16 herbicides to cause the nonthreshold effects of genetic mutations and cancer, respectively. The final subsection presents the details of the derivation of cancer potency for those herbicides suspected of being carcinogenic.

SOURCES OF TOXICITY INFORMATION

The toxicity of 12 of the herbicides (amitrole, atrazine, 2,4-D, 2,4-DP, dalapon, dicamba, fosamine, glyphosate, hexazinone, picloram, simazine, and triclopyr) to both laboratory animals and humans is described in detail in the background statements of the Forest Service Agricultural Handbook No. 633 (USDA, 1984). Tebuthiuron toxicity is described in a background statement prepared for the Forest Service as a supplement to Handbook No. 633. The toxicity of the herbicides asulam, diuron, and bromacil is described in background statements written in conjunction with this risk assessment. These documents are incorporated by reference into this Supplement to the Final Forest Service and BLM EISs identified in Section 1 in accordance with 40 CFR 1502.16 and are available for review at the BLM California State Office.

Much of the data on pesticide toxicity have been generated to comply with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended (7 U.S.C. 136 et seq), which establishes procedures for the registration, classification, and regulation of all pesticides, including herbicides. EPA is responsible for implementing FIFRA. Toxicity levels and related information from the series of studies submitted for registration are compiled by EPA in summary tables called "tox one-liners" that are available on request from EPA's Freedom of Information Office. EPA has compiled "science chapters" on many of the herbicides (amitrole, bromacil, dicamba, diuron, hexazinone, picloram, and simazine) and these are also available from EPA. A large body of additional toxicity information exists in the open literature, particularly for chemicals such as 2,4-D that have been used for many years.

An extensive literature search was funded by the U.S. Department of Agriculture, Forest Service, to ensure that all of the relevant available information was used in this risk analysis. The Medline data base, the Embase (Excerpta Medica) data base, and the International Pharmaceutical Abstract data base were searched to locate current literature pertaining to the carcinogenicity and mutagenicity of the herbicides.

The data from the U.S. Department of Agriculture, Forest Service, Pesticide Background Statements (1984) were reviewed and compared to summaries of studies submitted to the Environmental Protection Agency for the registration of the 16 herbicides. Whenever possible, studies that have been reviewed and validated by EPA were used to set toxicity reference levels. In no cases were studies used that have been invalidated by EPA.

HAZARD ANALYSIS TERMINOLOGY

Because of obvious limitations on the testing of chemicals on humans, judgments about the potential hazards of pesticides to humans are necessarily based on the results of toxicity tests on laboratory animals. These toxicity test results are supplemented by information on actual human poisoning incidents and effects on human populations when they are available. The discussion of laboratory toxicity testing that follows is drawn from Hayes (1982), Doull et al. (1980), and Loomis (1978).

Laboratory Toxicity Testing

Test Animal Species

Laboratory test animals function as models of the likely effects of the pesticide in humans. Ideally, the test animal should metabolize the compound the same as a human would and should have the same susceptible organ systems. Results of such tests then can be directly extrapolated to humans with some adjustment made for differences in body weight and body surface area. Although no test animal has proven ideal, a number of species have proven to be consistent indicators for certain types of toxicity tests, routes of administration, and types of chemicals; in particular, rats, mice, rabbits, hamsters, guinea pigs, dogs, and monkeys.

Toxic Endpoints and Toxicity Reference Levels

Toxicity tests are designed to produce specific toxic endpoints, such as fatality or cancer, and toxicity reference levels, such as a no-effect level. In addition to the test animal used, toxicity tests vary according to test duration, route of administration, dose levels, dosing schedule, number of test groups, and number of animals per group. Toxicity tests also vary on the basis of whether it is assumed that the effect in question is a threshold effect or a nonthreshold effect.

Threshold and Nonthreshold Effects

Most chemicals are assumed to have a threshold level of toxic effects on a local basis (at the site of administration) or systemic basis (acting throughout the body), below which no adverse effects occur to the test organism. Chemicals are generally thought to possess no such threshold level for cancer and mutations, thus these toxic endpoints may occur (with a certain level of probability) even in the presence of extremely small quantities of the substance. In this hazard analysis, threshold effects are discussed first, in the following subsection. The nonthreshold effects, mutagenicity and cancer, are discussed in the last two subsections.

Duration of Toxicity Tests

The duration of toxicity tests ranges from very short-term acute tests to longer subchronic studies to chronic studies that may last the lifetime of an animal. Acute toxicity studies involve administration of a single dose to each member of a test group (either at one time or in a cumulative series over a short period of less than 24 hours). Subchronic toxicity studies, used to determine the effects of multiple doses, usually last from a few days to 3 months (3 to 90 days) but generally less than one-half the lifetime of the test animal. Chronic studies, also used to determine the effects of multiple or continuous doses, normally last 2 years but generally more than one-half the test species' lifetime.

Routes of Administration

Routes of administration include oral via gavage (forced into the stomach with a syringe through a plastic tube) or fed in the diet, dermal (applied to the skin), inhalation (through exposure to vapors or aerosol particles), and parenteral (injection other than into the intestine) routes, such as subcutaneous (SC), which means injected under the skin, intraperitoneal (IP), meaning injected into the abdominal cavity, and intravenous (IV), meaning injected into a vein. Oral, dermal, and inhalation doses most nearly duplicate the likely routes of exposure to humans. Parenteral doses are used in testing drugs but are not widely used in toxicity testing of pesticides because they bypass the test animal's natural protective mechanisms. Doses are expressed in several ways. They can be expressed as milligrams (mg, which is 1/1,000 of a gram) of the chemical per kilogram (kg, which is 1,000 grams) of body weight of the test animal, or in parts per million (ppm) in the animal's diet, or in milligrams per liter (mg/L) in the air the animal breathes.

Dosing Levels

Dosing in longer term studies is generally done through the diet with specified amounts in parts per million in the food. The known weight of the test animals over the test period is used to convert ppm in the diet to milligrams of chemical per kilogram of body weight per day (mg/kg/day) for extrapolation to humans. Generally, at least three dosing levels are used in addition to a zero dose or control group. Animals of each sex usually are dosed in groups of 8 to 50.

Types of Toxicity Studies

Acute Toxicity Studies

Acute toxicity studies are used to determine the toxicity reference level known as the median lethal dose (LD_{50}), which is the dose that kills 50 percent of the test animals. The lower the LD_{50}, the greater the toxicity of the chemical. The LD_{50} ranges and toxicity categories used in this risk assessment are those of the EPA classification system using rat LD_{50}s, as shown in Table H-2 (adapted from Walstad and Dost, 1984). Because lethality is the intended toxic endpoint, dose levels usually are set relatively high in acute studies. Toxic symptoms displayed by the animals may be recorded throughout the study, and tissues and organs are examined for abnormalities at the end of the test. The animal most commonly used for oral LD_{50}s is the rat. Rabbits are used most often to determine dermal LD_{50}s.

Because death represents the extreme toxic consequence for judging possible effects from the use of pesticides, the policies of regulating agencies regarding acceptable intake levels of these chemical compounds are most often based not on acute studies, but rather on toxicity tests designed to find the dose level that produces no effects in the animal species tested. Figure H-2 illustrates the relationship between the LD_{50} and the no-effect level.

Subchronic Toxicity Studies

Subchronic studies are designed to determine the toxicity reference level called the no-observed-effect level (NOEL), which is the highest dose level at which no toxic effects are observed. If a chemical produces effects at the lowest dose tested (LDT) in a study, the NOEL must be at some lower dose. If the chemical produces no effects, even at the highest dose tested (HDT), the NOEL is equal to or greater than the HDT. Another toxic endpoint of interest is the lowest dose showing toxic effects, the lowest effect level (LEL). For local and systemic effects, the chemical's threshold of effect lies between the NOEL and LEL for the tested species (see Figure H-2).

Subchronic studies, normally employing lower dose levels than acute studies, provide information on systemic effects, cumulative toxicity, the latency period (the time between exposure and the manifestation of a toxic effect), the reversibility of toxic effects, and appropriate dose ranges to be used in chronic tests. The adverse effects may include death; decreased rate of food consumption; change in body weight; decreased enzyme levels; changes in blood constituents, such as red blood cells (RBCs) or white blood cells (WBCs); undesirable constituents in the urine; or microscopic changes in tissues.

Teratogenicity tests. Teratogenicity tests (teratology studies) determine the potential of a chemical to cause malformations in an embryo or a developing fetus between the time of conception and birth. These studies generally use pregnant female rats or rabbits dosed during the middle period of gestation while the organs of the fetus are developing. The animals are monitored for functional as well as structural deformities.

Table H-2
Acute Toxicity Classification and Acute Toxicities of the 16 Herbicides and Other Chemicals

Toxicity Category[1] (label signal words)	Herbicide or Other Chemical Substance	Oral LD_{50} for Rats (mg/kg)	Equivalent Human Dose
IV Very slight		5,000 - 50,000 (range)	More than 1 pint
	Sugar	30,000	
	Fosamine	24,400	
	Ethyl alcohol	13,700	
	Picloram	8,200	
	Dalapon	7,577	
III Slight (caution)		500 - 5,000 (range)	1 ounce to 1 pint
	Simazine	5,000	
	Glyphosate	4,320	
	Amitrole	4,080	
	Asulam	4,000	
	Bromacil	3,998	
	Table salt, diuron	3,750	
	Bleach	2,000	
	Atrazine	1,869	
	Aspirin, Vitamin B_3	1,700	
	Hexazinone	1,690	
	Dicamba	757	
	Tebuthiuron	644	
	Triclopyr	630	
	2,4-DP	532	
II Moderate (warning)		50 - 500 (range)	1 teaspoon to 1 ounce
	2,4,5-T	500	
	2,4-D	375	
	Caffeine	200	
	DDT	100	
I Severe (danger - poison)		0 - 50 (range)	1 teaspoon or less
	Nicotine	50	
	Strychnine (rodenticide)	30	
	Parathion (insecticide)	13	
	TCDD (dioxin)	0.001	
	Botulinus Toxin	0.00001	

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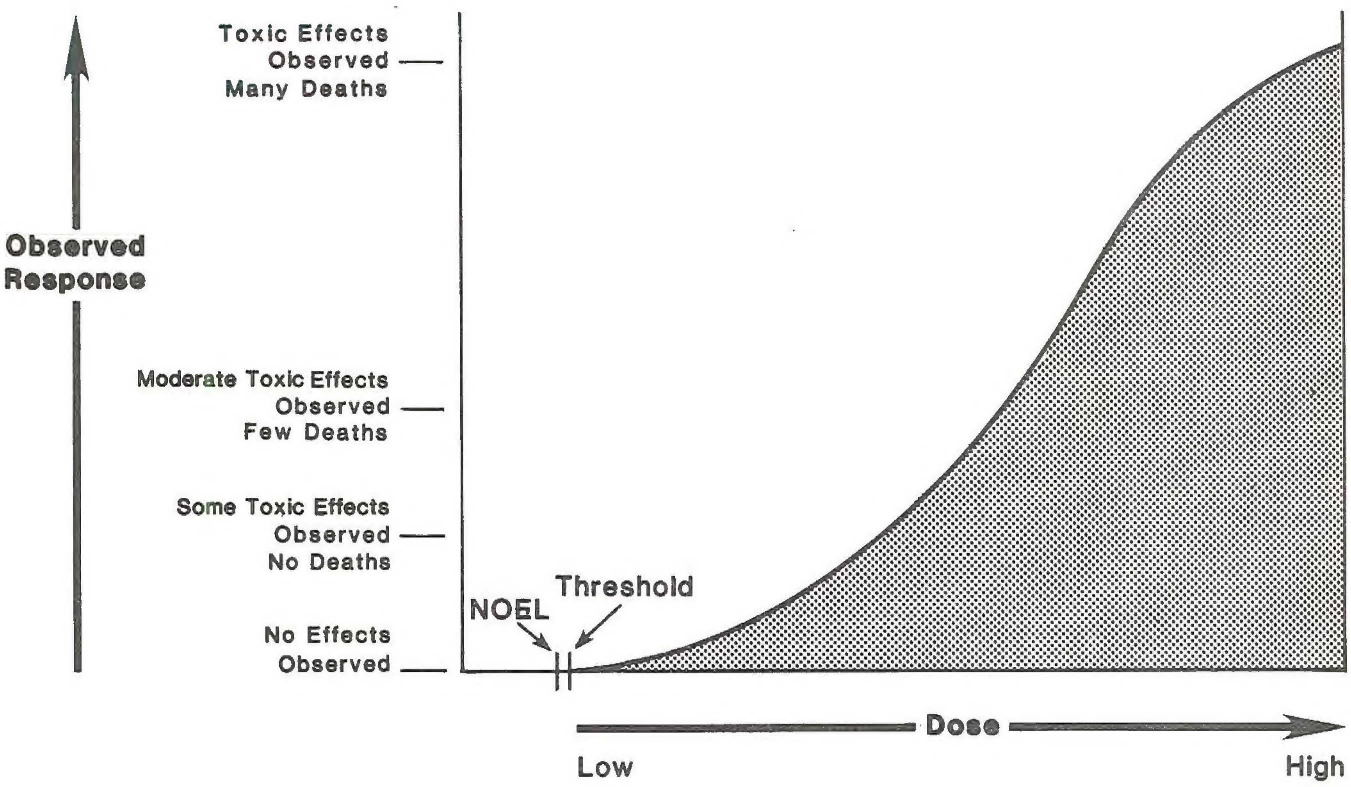
[1] Categories, signal words, and LD_{50} ranges are based on a classification system used by the EPA for labeling pesticides.

Source: Maxwell, 1982 (as cited in Walstad and Dost, 1984).



LD_{50} - Acute lethal dose. One-time or short-term dose that is lethal to 50 percent of treated animals.

Threshold - Dose level at which toxic effects are first observed in animals.

NOEL - No-observed-effect level. Long-term dose that does not result in apparent adverse effects in test animals.

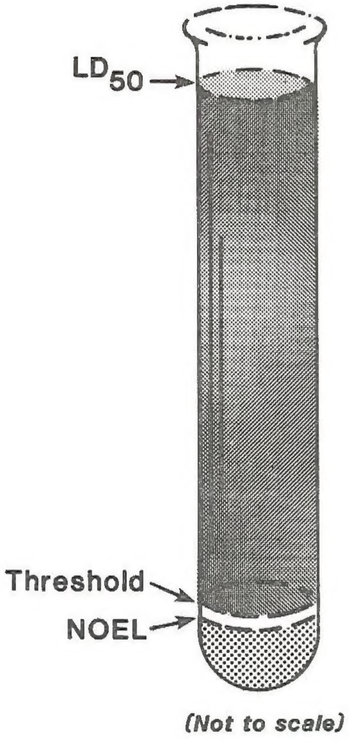


Figure H-2 Relationships Among Toxicity Reference Levels

Chronic Toxicity Studies

Chronic studies, like subchronic studies, can be used to determine systemic NOELs. All other things being equal, the longer the study from which the NOEL is derived, the more reliable the resulting value. Chronic studies, however, are even more important in determining doses that are hazardous to reproductive success or in determining whether the chemical causes cancer. Chronic tests include feeding studies, reproduction studies, and carcinogenicity tests.

Reproduction studies. Reproduction studies are conducted to determine the effect of the chemical on reproductive success as indicated by fertility direct toxicity to the developing fetus, and survival and weight of offspring for low-level, long-term exposure. These tests are usually performed at lower doses than those used in teratogenicity studies and generally use rats. Both male and female rats are exposed to the chemical for a number of weeks before mating. The number of resulting pregnancies, stillbirths, and live births are recorded. Tests may be conducted over two or three generations.

Carcinogenicity tests. Carcinogenicity tests (cancer studies or oncogenicity studies) examine the potential for a chemical to cause tumors when fed in the diet over the animal's lifetime. Testing is normally conducted with rats or mice for a 2-year period.

Mutagenicity Assays

Mutagenicity assays are used to determine the ability of a chemical to cause physical changes (mutations) in the basic genetic material (DNA) that could be passed on from one generation to the next. The species used in these tests range from primitive organisms, such as the bacteria Salmonella, Escherichia, and Streptomyces; the mold Aspergillus; the yeast Saccharomyces; and the fruit fly Drosophila, to the more advanced organisms that include mammalian species. Tests may be conducted in vivo (within the body of the living organism) or in vitro (on cells cultured outside the body in a petri dish or test tube). There are many types of tests in this category, including the dominant lethal assay, which is usually conducted with rodents, and the Ames reverse mutation test, which is conducted with bacteria. The subsection on mutagenicity of the 16 herbicides gives more information about mutagenicity tests.

THRESHOLD TOXICITY OF THE 16 HERBICIDES

The toxicity reference levels used in this risk assessment to describe both acute and chronic threshold effects of the 16 herbicides are presented in Table H-3. The LD_{50}s in this table are from rat oral studies. Two types of NOELs are given in Table H-3. The first NOEL is for general systemic effects, such as growth retardation, decreased red blood cell counts, and increased thyroid weight. All of the systemic NOELs take into account validated 2-year chronic feeding studies. For amitrole, asulam, fosamine, picloram, tebuthiuron, and triclopyr, subchronic study NOELs were used because they are the lowest NOELs found in the literature. The second NOEL

Table H-3

Laboratory-Determined Toxicity Levels Used in the Risk Analysis

Herbicide	Acute Oral LD_{50} in Rats	Lowest Systemic NOEL	Lowest Reproductive and/or Teratogenic NOEL
Amitrole	Greater than 4,080 mg/kg (EPA, 1984a)	0.5 ppm (0.025 mg/kg/day), subchronic rat feeding study (EPA, 1985a)	100 ppm (5 mg/kg/day), 2-generation rat reproduction study (EPA, 1985a) No birth defects observed in any studies. Fetotoxic NOEL = 5,000 ppm (750 mg/kg/day) mouse teratology study (EPA, 1985a)
Asulam	Greater than 4,000 mg/kg (EPA, 1984b)	50 mg/kg/day, 107-week rat feeding study (EPA, 1985d)	1,000 ppm (50 mg/kg/day), 2-generation rat reproduction study (EPA, 1984b) Maternal NOEL = 300 mg/kg, rabbit teratology study (EPA, 1984b) No birth defects observed in any studies.
Simazine	Greater than 5,000 mg/kg (EPA, 1984n)	Greater than 100 ppm (5 mg/kg/day) (HDT), 2-year rat feeding study (EPA, 1984n)	Greater than 100 ppm (5.0 mg/kg/day) (ODT), 3-generation reproduction study (EPA, 1984n)
Tebuthiuron	644 mg/kg (DOE, 1983)	500 ppm (12.5 mg/kg/day), 90-day dog feeding study (EPA, 1975)	No birth defects. Greater than 1,800 ppm (90 mg/kg/day), reproduction rat study (Todd et al., 1974, in USDA, 1985b) 237 mg/kg, dermal teratology study (EPA, 1984o) Reproductive NOEL greater than 400 ppm (20 mg/kg/day) (HDT), 2-generation reproduction study with rats (EPA, 1985d)
Triclopyr	630 mg/kg (EPA, 1984p)	2.5 mg/kg/day (HDT), 6-month dog feeding study (40 CFR Part 180, 50(84):18485, May 1, 1985)	Fetotoxic NOEL less than 10 mg/kg, rabbit teratology study (EPA, 1984p) No teratogenic effects greater than 30 mg/kg (HDT), 3-generation rat reproduction study (USDA, 1984) Reproductive NOEL greater than 400 ppm (20 mg/kg/day) (HDT), 2-generation reproduction study with rats (EPA, 1985d)
Fosamine	24,200 mg/kg (EPA, 1984j)	1,000 ppm (25 mg/kg/day) 6-mongh dog feeding study (Schneider and Kaplan, 1983 in USDA, 1984)	Greater than 10,000 ppm (500 mg/kg/day), rat teratology study (Schneider and Kaplan in USDA, 1984)
Glyphosate	4,320 mg/kg (EPA, 1984k)	Greater than 31 mg/kg/day, 26-month rat feeding study (EPA, 1984k)	10 mg/kg, 3-generation reproduction rat study (EPA, 1984k) Maternal NOEL = 175 mg/kg rabbit teratology study (USDA, 1984). No birth defects.

Table H-3 (Cont.)
Laboratory-Determined Toxicity Levels Used in the Risk Analysis

Herbicide	Acute Oral LD_{50} in Rats	Lowest Systemic NOEL	Lowest Reproductive and/or Teratogenic NOEL
Hexazinone	1,690 mg/kg (EPA, 1984)	200 ppm (10 mg/kg/day), 2-year rat feeding/oncogenic study (EPA, 1984l)	1,000 ppm (50 mg/kg/day), 3-generation reproduction rat study (USDA, 1984) 125 mg/kg (HDT), rabbit teratology study (USDA, 1984)
Picloram	8,200 mg/kg, rat	7 mg/kg, 6-month dog feeding study (Muillison, 1985)	No teratogenic effects in 3 studies 1,000 ppm (50/mg/kg/day), rat 3-generation reproduction study (EPA, 1984m)
2,4-DP	532 mg/kg, rat (EPA, 1984f)	50 mg/kg, 2-year rat feeding study (EPA, 1984f) 5 mg/kg, 13-week rat feeding study (EPA, 1985)	Three-generation rat reproduction study, NOEL = 125 ppm (6.25 mg/kg/day) (EPA, 1984f) Teratogenic effects at 25 mg/kg/day (LDT). Maternal and fetotoxic NOEL = 25 mg/kg/day, rabbit (EPA, 1984f)
Dalapon	7,577 mg/kg (EPA, 1984g)	15 mg/kg, 2-year rat feeting study (USDA, 1984)	Greater than 300 mg/kg/day, 3-generation rat reproduction study (USDA, 1984)
Dicamba	757 mg/kg (USDA, 1984)	500 ppm (25 mg/kg/day), 90-day subchronic feeding study (EPA, 1984h)	No teratogenic effects reported in 4 studies. Fetotoxic and maternal NOEL = 3.0 mg/kg/day, rabbit teratology study (EPA, 1984h) Reproductive NOEL = 2.5 mg/kg/day (EPA, 1985d)
Diuron	3,750 mg/kg (EPA, 1984i)	25 ppm (0.625 mg/kg/day) 2-year dog feeding study (EPA, 1984i)	No birth defects. NOEL greater than 125 ppm, 2-generation rat reproduction study (6.25 mg/kg/day) (Hodge et al., 1967; EPA, 1984i)
Atrazine	1,869 mg/kg (EPA, 1984c)	150 ppm (3.7 mg/kg/day), 2-year dog feeding study (EPA, 1984c)	No birth defects in two studies. Three-generation reproductive NOEL of greater than 100 ppm (50/mg/kg/day), rat (EPA, 1984c) 100 mg/kg/day fetotoxic NOEL rat teratology study (EPA, 1984c)
Bromacil	3,998 mg/kg (EPA, 1984d)	250 ppm (6.25 mg/kg/day) 2-year dog feeding study (EPA, 1984d)	No teratogenic effects in two studies Greater than 165 mg/m^3 (7./9 mg/kg/day HDT), rat teratology study (EPA, 1984d)
2,4-D	375 mg/kg (EPA, 1984e)	1.0 mg/kg, first year results from 2-year rat feeding study (EPA, 1985c)	Fetotoxic and maternal NOEL = 5 mg/kg/day, rat teratology study (EPA, 1986b)

Conversion Factors:
mouse 1 ppm = 0.150 mg/kg/day
rat (lifetime) 1 ppm = 0.05 mg/kg/day
rabbit 1 ppm = 0.030 mg/kg/day
dog 1 ppm = 0.025 mg/kg/day

Source: USDA, 1984

is for reproductive effects, including infertility, miscarriage, general fetal toxicity, and birth defects (teratogenesis). Where information is available, NOELs are given for both reproductive and teratogenic effects. All the NOELs used are the lowest found in validated studies.

The following subsections summarize the most relevant acute and chronic toxicity tests that have been conducted on 16 herbicides. Areas where no validated studies exist or in which EPA has requested additional studies are noted.

Amitrole

Amitrole can be classified as slightly toxic (see Table H-2) based on the acute oral LD_{50} value in rats of greater than 4,080 mg/kg (EPA, 1984a). The lowest systemic NOEL found in the literature, based on thyroid effects in a subchronic feeding study with rats, was reported to be 0.5 ppm (0.025 mg/kg/day) (EPA, 1985a).

EPA's risk assessment of amitrole (EPA, 1985a) states the following:

> In a subchronic feeding study (Fregly, 1968), male rats were fed 0, 0.25, 0.50, 2.00, 10, and 50 ppm amitrole in the diet for 11 or 13 weeks. Thyroid iodine uptake was reduced, and enlarged thyroids were observed in animals fed 2.00, 10, and 50 ppm. Significant functional changes had already occurred after only 1 week of feeding.
>
> In addition, another subchronic feeding study (Food Drug Research Labs, 1977) fed male rats 0, 30, 100, and 300 ppm amitrole in the diet for 4 weeks followed by 4 weeks on control diet. The study was designed to demonstrate the reversibility of the antithyroid effects of amitrole. Reduced levels of T_3 and T_4 were reported in the 100 and 300 ppm groups after 14 and 7 days, respectively, on the amitrole diets. After 21 days on the control diet during the recovery phase of the study, all treatment groups had T_3 and T_4 values similar to concurrent control values.
>
> In a 2-generation reproduction study, groups of male and female rats (F_0) were fed 500 and 1,000 ppm amitrole for 107 to 110 days. Two other groups were fed 25 and 100 ppm for 240 to 247 days, and their progeny (F_1) were fed 25 and 100 ppm amitrole for 141 days (Gaines, 1973). Pups born to parents fed 500 and 1,000 ppm amitrole were small, and had atopic thymuses and spleens indicative of runting; no signs of runting were observed in the 25 and 100 ppm pups. Hyperplasia of the thyroid was observed in all animals fed 25 ppm and higher.
>
> No teratogenic effects were observed at birth through weaning when pregnant rats were orally gavaged from day 7 through 15 of gestation with 20 and 100 mg/kg/day of amitrole (Gaines, 1973). In another teratology study, pregnant mice were treated with 500, 1,000, 2,500, and 5,000 ppm amitrole in the drinking water

> from day 6 through 18 of gestation (Tjalve, 1974). No teratogenic effects were observed. Indications of fetotoxic effects were observed in the 1,000, 2,500, and 5,000 ppm treatment groups. These effects were small fetuses, underdeveloped fetuses with immature skeletons, and increased number of resorptions (5,000 ppm group only).
>
> The body of nononcogenic data indicates that amitrole has a low acute toxicity in experimental animals. However, amitrole is a potentially potent antithyroid agent as evidenced by the low subchronic feeding levels (2 ppm) that resulted in significant effects on thyroid function. The data also indicate that amitrole does not pose a significant reproductive hazard. However, the data are insufficient to assess teratogenic potential.

EPA has requested additional data to assess the teratogenic potential of amitrole.

Asulam

Based on the acute oral LD_{50} of greater than 4,000 mg/kg in rats (EPA, 1984b), asulam can be classified as slightly toxic (see Table H-2). The systemic NOEL of 2,000 ppm (100 mg/kg/day) was based on fatty deposits in the liver derived from a 90-day rat feeding study (EPA, 1984b). A 6-month dog feeding study established a NOEL of 60 mg/kg/day (EPA, 1984b). A systemic NOEL of 50 mg/kg/day was determined for a 107-week feeding study with rats (EPA, 1985d).

Teratology and multigeneration reproduction studies indicate that asulam does not cause teratogenic or fetotoxic effects in test animals. A 2-generation rat reproduction study also resulted in the absence of terata and fetotoxic effects at 1,000 ppm (50 mg/kg/day); however, reproductive effects characterized by a decrease in the number of live births were reported at 5,000 ppm (250 mg/kg/day) and 25,000 ppm (1,250 mg/kg/day) (EPA, 1984b). The highest NOEL reported for a rabbit teratology study was 300 mg/kg, with no teratogenic or fetotoxic effects reported (EPA, 1984b). A rat teratology study resulted in the absence of any toxic effects and a NOEL established at greater than 40 mg/kg/day (HDT) (EPA, 1984b).

Atrazine

Atrazine can be classified as a slightly toxic herbicide, based on the acute oral LD_{50} of 1,869 mg/kg in rats, with labored breathing observed in surviving animals (EPA, 1984c). A 2-year dog feeding study resulted in the establishment of a systemic NOEL of 150 ppm (3.7 mg/kg/day) based on a decrease in body weight (EPA, 1984c). Atrazine has produced mammary tumors in rats. A recently completed 2-year feeding/oncogenicity study in rats resulted in a systemic NOEL of 70 ppm (3.5 mg/kg/day) based on reduced body weight, reduced red blood cell parameters and decreased glucose levels (EPA, 1986). A 3-generation reproduction study in rats reported no reproductive or systemic effects at the highest dose tested (100 ppm or 5 mg/kg/day) (EPA, 1984c). Fetotoxic effects characterized as weight loss and fetal resorptions occurred at a dose level of 500 mg/kg in a rat teratology study (EPA, 1984c). A mouse teratology study reported no significant increases in fetal abnormalities at 46.4 mg/kg (Hayes, 1982).

Bromacil

Based on the acute oral LD_{50} of 3,998 mg/kg in rats (EPA, 1984d), bromacil can be classified as slightly toxic. A systemic NOEL of 250 ppm (6.25 mg/kg/day) was derived from a 2-year dog feeding study that indicated decreases in body weights (EPA, 1984d). There have not been any teratogenic or fetotoxic effects reported from teratology studies that established a NOEL greater than 250 ppm (7.5 mg/kg/day) for rabbits and a NOEL greater than 7.92 mg/kg for rats (EPA, 1984d).

2,4-D

2,4-D can be classified as moderately toxic (see Table H-2) in mammals with an LD_{50} in rats of 375 mg/kg (EPA, 1984e). Acute and chronic toxicity studies in mammals revealed general systemic toxic effects following ingestion of large doses of 2,4-D. Similar clinical symptoms have been observed in human case reports. Even though dermal absorption of 2,4-D is limited, the herbicide has been reported to produce peripheral neuropathy in a few individuals after accidental exposure. In several cases the recovery has not been complete (USDA, 1984). A 2-year dog feeding study with dose levels of 2,4-D ranging from 0 to 500 ppm (0 to 12.5 mg/kg) established a systemic NOEL of 12.5 mg/kg/day (HDT) (EPA, 1984e). A systemic NOEL of 1,250 ppm (62.5 mg/kg/day) was established for a 2-year rat feeding study (EPA, 1984e).

Results from the first year of a chronic feeding study on rats have been reviewed by EPA (EPA, 1985c). Based on kidney effects, a NOEL of 1 mg/kg/day was established; the lowest effect level was 5 mg/kg/day. Based on this study using a hundredfold safety factor, EPA has established a provisional ADI of 0.01 mg/kg/day.

Fetotoxic and maternal toxic NOELs of 5 mg/kg/day are based on a study with rats exposed to 2,4-D acid at 5, 20, and 80 mg/kg/day. Decreased maternal body weight and reduced pup weight were observed at 20 mg/kg/day (EPA, 1986b). There were no teratogenic effects observed in the offspring of rats exposed to 2,4-D (EPA, 1985c).

2,4-DP

2,4-DP can be classified as slightly toxic. Two studies reported LD_{50}s of 650 mg/kg for mice and 532 mg/kg for rats (EPA, 1984f). A subchronic 90-day rat feeding study established a NOEL of 5 mg/kg. At higher doses, enzymes in the blood, hemoglobin, and kidney and liver weights were affected. A systemic NOEL of 100 mg/kg/day (EPA, 1984f) based on increased liver weights was established for an 18-month mouse feeding study. Two-year feeding studies with rats determined a systemic NOEL of 50 mg/kg/day. At the LEL, all of the following effects were observed: decreased weight gain, decreased hematocrit and red blood cells, chronic prostatitis, and kidney degeneration (EPA, 1984f).

A fetotoxic NOEL of 125 ppm (6.25 mg/kg/day) was reported for a 3-generation rat reproduction study, with increased mortality of pups occurring at 500 ppm (25 mg/kg/day) (EPA, 1984f). A rabbit teratology study determined fetotoxic and maternal NOELs of 25 mg/kg and a teratogenic NOEL of less than 25 mg/kg, which was the lowest dose tested. Teratogenic effects characterized by displaced kidneys, navel hernia, and distorted ribs occurred at 25 mg/kg in rabbits. Fetotoxic effects such as reduction in fetal weight and reduction in crown-rump distance were reported at a dose level of 100 mg/kg/day in rabbits. Maternal toxic effects such as unsteadiness in gait, reduced food intake, and mortality were also observed at the rabbit dose level of 100 mg/kg/day.

Dalapon

Based on the acute oral LD_{50} of 7,577 mg/kg in the rat (EPA, 1984g), dalapon can be classified as slightly toxic (see Table H-2). A systemic NOEL of 15 mg/kg/day was reported for a 2-year rat feeding study based on increases in kidney weights (Paynter et al., 1960, as cited in USDA, 1984). A systemic NOEL of 50 mg/kg/day was reported for a 52-week dog feeding study which also indicated an increase in kidney weights (Paynter et al., 1960, as cited in USDA, 1984). Histology sections of test animal tissues revealed no abnormal pathology or evidence of tumorigenesis due to exposure to dalapon (USDA, 1984). The lowest NOEL reported for teratology studies is 300 mg/kg/day for the rat (USDA, 1984). The only toxic effect noted to occur after maternal exposure to dalapon is reduced weight of pups. The Environmental Protection Agency has initiated a data call-in for a reassessment of the reregistration of dalapon (EPA, 1984g).

Dicamba

Based on an acute oral LD_{50} of 757 mg/kg in the rat, dicamba can be classified as slightly toxic (USDA, 1984) (see Table H-2). A number of subchronic rat studies and one 2-year rat study did not find any adverse effects at the highest dose tested (EPA, 1984h). EPA reports an in-house value of 250 mg/kg/day for systemic effects (EPA, 1985d). EPA has requested additional chronic studies for dicamba. A 90-day subchronic feeding study in rats established a NOEL of 500 ppm (25 mg/kg/day) based on slight liver cell alterations. This NOEL is similar to a NOEL from a chronic mouse study reported in DOE, BPA, 1984 and, because it is more conservative, will be used in this risk analysis.

Fetotoxic and maternal toxic effects have been observed in laboratory animals exposed to dicamba. A fetotoxic NOEL of 0.5 mg/kg was reported for a rabbit teratology pilot study, with resorptions reported at 1.0 mg/kg (EPA, 1984h). A second rabbit teratology study resulted in a maternal NOEL and a fetotoxic NOEL of 3.0 mg/kg (EPA, 1984h). Recent information from EPA (1985d) has placed the reproductive NOEL of dicamba at 2.5 mg/kg.

Diuron

Based on the acute oral LD_{50} of 3,750 mg/kg (EPA, 1984i), diuron can be classified as slightly toxic (see Table H-2). A systemic NOEL of 125 ppm (6.25 mg/kg/day) was derived from a 2-year rat feeding study (EPA, 1984i).

A systemic NOEL of 25 ppm (0.625 mg/kg/day) was reported for a 2-year dog feeding study (EPA, 1984i). (Awaiting information from EPA on these studies.) A 3-generation rat reproduction study resulted in the absence of any reproductive effects at the only dose tested of 125 ppm (6.25 mg/kg) (EPA, 1984i). In that same study, a systemic NOEL of less than 125 ppm (6.25 mg/kg/day) was established based on body weight depression of litters (EPA, 1984i).

Fosamine

Based on the acute oral LD_{50} of 24,400 mg/kg in the rat for the formulated product (USDA, 1984), fosamine can be classified as very slightly toxic.

A systemic NOEL of 1,000 ppm (25 mg/kg/day) was reported for a 6-month dog feeding study, with increased stomach weight being the only toxic effect noted (Schneider and Kaplan, 1983, in USDA, 1984). A systemic NOEL between 5,000 and 10,000 ppm (250 mg/kg/day to 500 mg/kg/day) (HDT) was established for a 90-day rat feeding study (Schneider and Kaplan, 1983, in USDA, 1984).

NOELs of 10,000 ppm (500 mg/kg/day) and 5,000 to 10,000 ppm (250 to 500 mg/kg/day) were reported for rat teratology studies (Schneider and Kaplan, 1983, in USDA, 1984). No fetal toxic, teratogenic, or reproductive toxic effects were observed in either of the teratology studies.

Glyphosate

Based on the acute oral LD_{50} of 4,320 mg/kg (EPA, 1984k) in the rat, glyphosate can be classified as slightly toxic (see Table H-2). A 26-month rat feeding study found no observable effects, including cancer, at the highest dose tested. Based on this study, EPA established a NOEL of greater than 31 mg/kg/day (HDT) (EPA, 1984k). A 3-generation reproduction study of glyphosate in rats established a NOEL of 10 mg/kg/day (EPA, 1984k). This NOEL was based on renal tubular dilation in the kidneys of the pups; no effects on fertility or reproductive parameters were noted. Based on this study, EPA has established an acceptable daily intake (ADI) level of 0.1 mg/kg/day. Maternal NOELs for two teratology studies in rats and rabbits were 1,000 mg/kg/day and 175 mg/kg/day, respectively (EPA, 1984k).

Hexazinone

Hexazinone can be classified as slightly toxic based on the acute oral LD_{50} of 1,690 mg/kg (EPA, 1984l). The systemic NOEL based on 2-year mice and rat feeding studies was established as 200 ppm (30 mg/kg/day, mice; 10 mg/kg/ day, rats) (EPA, 1984l). The toxic effects observed during the mouse study were increases in liver size, a localized increase in liver cells, and localized tissue degeneration at the lowest effect level of 2,500 ppm (375 mg/kg mice, 125 mg/kg rats). Twenty mg/kg/day was the lowest NOEL reported for rabbit teratology studies (USDA, 1984). A 3-generation reproduction study established a NOEL of 1,000 ppm (50 mg/kg/day) in rats (USDA, 1984). A rabbit teratology study reported both a terata and fetotoxic NOEL greater than 125 mg/kg (HDT) (EPA, 1984l).

Picloram

Based on the acute oral LD_{50} of 8,200 mg/kg in rats (EPA, 1984m), picloram can be classified as very slightly toxic. A 6-month dog feeding study, during which test animals were exposed to picloram at the dietary levels of 0, 7, 35, and 175 mg/kg/day, resulted in a chronic NOEL of 7 mg/kg/day (Barna-Lloyd et al., 1982, as cited in Mullison, 1985). Increased liver weights were reported at the lowest effect level of 35 mg/kg/day in males (DOW Chemical Company, 1984).

Two chronic feeding studies performed by IBT have been invalidated by EPA (1984m). EPA has asked for additional data on chronic rodent and non-rodent studies.

The lowest reproductive NOEL reported for picloram is 1,000 ppm (50 mg/kg/day) in rats, with reduced fertility at the lowest effect level of 3,000 ppm (150 mg/kg/day) (EPA, 1984m). In a rat teratology study, minor skeletal abnormalities related to maternal toxicity were observed at 750 mg/kg/day. No deformed offspring or adverse effects to development of the newborn offspring were observed at the highest dose tested (1,000 mg/kg). A teratology study using mice as the test species observed no adverse effects on fertility or number of offspring after exposure to 15 mg/kg/day of picloram (USDA, 1984).

Simazine

Based on the acute oral LD_{50} of greater than 5,000 mg/kg in the rat (EPA, 1984n) simazine can be classified as very slightly toxic (see Table H-2). A systemic NOEL greater than 100 ppm (5 mg/kg/day) (HDT) was reported for a 2-year rat feeding study (EPA, 1984n). A 2-year dog feeding study did not find any overt signs of toxicity at 1,500 ppm (37.5 mg/kg/day) (HDT). EPA, however, has determined that chronic toxicity and oncogenic potential could not be determined from either of these studies. A 3-generation rat reproduction study established a NOEL greater than 100 ppm (5 mg/kg/day); there were no reported teratogenic, fetotoxic, or reproductive effects at the highest dose tested (EPA, 1984n). EPA has requested additional studies on subchronic toxicity, teratogenicity, and chronic toxicity.

Tebuthiuron

Based on the acute oral LD_{50} of 644 mg/kg in rats (Todd et al., 1974, in DOE, 1983), tebuthiuron can be classified as slightly toxic. A systemic NOEL of 554 ppm (83.1 mg/kg/day) (EPA, 1984o) was established from a 119-day mouse feeding study. A systemic NOEL of 500 ppm (12.5 mg/kg/day) was established for a 3-month dog feeding study based on increased thyroid-to-body weight values and increased blood enzyme levels. A reproductive NOEL of greater than 400 ppm (20 mg/kg/day) (HDT) was determined in a 2-generation reproduction study with rats (EPA, 1985d). Tebuthiuron did not produce any terata among the offspring of rats at the highest dose tested of 1,800 ppm (90 mg/kg) (Todd et al., 1974, as cited in USDA, 1985b). A reproductive NOEL of 90 mg/kg/day is used in this risk assessment because neither of the studies reported above showed reproductive effects at the highest doses tested. A dermal teratology study in rats resulted in a NOEL of 237 mg/kg/day (EPA, 1984o).

Triclopyr

With an acute oral LD_{50} ranging from 630 to 729 mg/kg in rats (EPA, 1984p), triclopyr can be classified as slightly toxic (see Table H-2). A systemic NOEL of 30 mg/kg/day (HDT) was established for both rat and mouse 2-year feeding studies (EPA, 1984p; USDA, 1984). EPA does not consider this study adequate and has requested additional chronic studies. A 228-day dog feeding study resulted in a systemic NOEL of less than 5 mg/kg/day, based on decreased weight gain and food consumption (Dow Chemical Company, 1983, in USDA, 1984). A 6-month feeding study with dogs resulted in a systemic NOEL of 2.5 mg/kg (HDT) (40 CFR Part 180 5(84):18485 May 1, 1985). The effects found in the dog studies are not representative of effects expected in humans because dogs have a limited capacity for organic anion transport in the kidney. Dogs excrete triclopyr at a slower rate than other laboratory animals or humans. The half-life of triclopyr for urinary excretion in dogs is 96 hours as compared to 1.5 hours in rats and 3.1 hours in monkeys. Toxicity may be increased in dogs because of the greater relative retention time of the compound in the animal's body. Therefore, the use of the NOEL from the dog study (the lowest NOEL found in the literature) in this risk assessment is very conservative and tends to overestimate expected effects in humans.

Laboratory results indicate that triclopyr has caused mild fetotoxicity characterized by delayed ossification of the skull in the offspring of rats exposed to 200 mg/kg/day (USDA, 1984). No teratogenic or reproductive toxic effects were observed during a 3-generation rat reproduction study establishing a NOEL of greater than 30 mg/kg/day (HDT) (USDA, 1984). A NOEL less than 25 mg/kg/day was established for a rabbit teratology study in which there were no teratogenic effects reported, but fetotoxic effects were observed at the dose levels of 25, 50, and 100 mg/kg/day (USDA, 1984). A fetotoxic NOEL of less than or equal to 10 mg/kg was established in a study with rabbits (EPA, 1984p).

MUTAGENICITY OF THE 16 HERBICIDES

This subsection presents a review of the currently available information on the mutagenic hazard of the 16 herbicides. Table H-4 summarizes the validated tests on each of the 16 herbicides for each category of testing recommended by EPA in their guidance documents on mutagenicity (EPA, 1978 and EPA, 1984r). Table H-4 also presents the relevance of the recommended tests to a determination of human mutagenic potential according to Dr. David Brusick (see Section 5).

In general, the most relevant mutagenic assays are in vivo cell studies and germ cell or gonadal studies (e.g., Drosophila fruit fly sex-linked recessive studies). A germ cell study is considered relevant to evaluating the mutagenicity of a chemical even if the test organism is not mammalian. In vitro studies using mammalian cells are of less importance because of the high percentage of false positive findings induced as a result of interactions between the cultured cells and media conditions. Tests for detecting primary DNA damage (Group 3 in Table H-4) are not useful in determining the human mutagenic potential of a chemical.

Table H-4
Mutagenicity Testing on the 16 Herbicides[a]

Mutagenicity Test Type[c]	Value in Determining Human Mutagenicity[b]	Herbicide												
		Amitrole	Asulam	Atrazine	2,4-D	2,4-DP	Dicamba	Fosamine	Glyphosate	Hexazinone	Picloram	Simazine	Tebuthiuron	Triclopyr
Group 1--Tests for detecting gene mutations														
A. Bacteria with and without metabolic activation	I	2(+)56(-)	1(-)	3(+)7(-)	2(+)13(-)	4(-)	3(-)	1(-)	3(-)	2(-)	1(+)5(-)	9(-)	1(-)	1(-)
B. Eukaryotic microorganisms with and without metabolic activation	I			3(+)	1(+)1(-)	1(+)			1(-)		3(-)			
C. Insects (e.g., sex-linked recessive lethal test)	II	3(-)		1(+)1(-)	1(+)1(-)							2(+)		
D. Mammalian somatic cells in culture with and without metabolic activation	II		1(-)	1(+)				1(-)	1(-)	1(-)			1(+)	
E. Mouse specific locus test in vivo	II													
Group 2--Tests for detecting chromosomal aberrations														
A. Cytogenetic tests in mammals in vivo	II	2(-)		2(+)	1(+)1(-)			1(-)		1(-)	1(-)			
B. Insect tests for heritable chromosomal effects in vivo	II													
C. Dominant-lethal effects in rodents, heritable translocation tests in rodents, and in vitro cytogenetic assays in mammals	II	4(+)	1(-)	1(+)3(-)	2(-)		1(-)	1(+)	2(-)	1(+)				1(+)2(-)
Group 3--Tests for detecting primary DNA damage														
A. DNA repair in bacteria (including differential killing of DNA repair defective strains) with and without metabolic activation	NA					2(+)	2(+)							1(-)
B. Unscheduled DNA repair synthesis in mammalian somatic cells in culture, with and without metabolic activation	NA			1(+)	2(-)		1(-)	1(-)	1(-)	1(-)		1(-)		
C. Mitotic recombination and gene conversion in yeast, with and without metabolic activation	NA			3(+)6(-)	2(+)3(-)	1(+)	1(-)					2(-)		
D. Sister-chromatid exchange in mammalian cells in culture, with and without metabolic activation	NA	2(-)		1(-)	1(+)								*	

[a] No validated mutagenicity studies are available for bromacil, dalapon, and diuron.

[b] Value in Determining Human Mutagenicity Source: USDA, 1985a

[c] Source: FIFRA, Environmental Protection Agency: Proposed Guidelines for registering pesticides in the U.S. Hazard Evaluation: humans and domestic animals. Fed. Reg. 43:37335-37403, August 22, 1978.

NA = Not Applicable
I = Applicable
II = Greater applicability
* = Inconclusive
+ = Positive results in Assays
- = Negative results in Assays

Source for Mutagenicity Data: USDA, 1984; EPA, 1985d

For some of the herbicides, no validated mutagenicity tests exist or the mutagenicity tests conducted are insufficient to conclude whether the chemical is mutagenic. For these herbicides, the worst case analysis presented in Section 4 assumed that these herbicides are mutagenic. In these cases the results of carcinogenicity tests (see Table H-5) were used to estimate mutagenic risk, because there is no widely accepted scientific method to quantify mutagenic risks directly from mutagenicity test data.

Details of the mutagenicity testing on the 16 herbicides are presented in Attachment A.

Amitrole

Amitrole did not produce mutagenic effects in 58 bacterial assays. Positive results were observed in two tests in an unvalidated system with unusual bacteria. EPA has determined that amitrole does not present a potential for genetic effects. The chemical induced transformations in four in vitro assays with mammalian cells (EPA, 1985a). EPA has stated that these results support cancer potential, but not necessarily mutagenic potential.

Asulam

There is no evidence to indicate that asulam has mutagenic potential. Asulam was nonmutagenic when tested in a bacterial assay and assays using mammalian cells in vitro and in vivo (EPA, 1984b).

Atrazine

Atrazine was positive for mutagenicity in eight gene mutation studies and negative in eight others. Three of these positive responses were in tests with the fruit fly that measured gene mutations in germ cells. Positive results were also obtained in tests with mice which measured chromosome alterations in germ cells. Positive responses in these types of assays indicate a potential for mutagenic hazard. Chromosome aberrations in bone marrow cells in vivo support this conclusion. However, these in vivo responses were observed only at very high levels of atrazine equal to or exceeding 1.5 gm/kg (USDA, 1984). Atrazine was nonmutagenic in two microbial mutagenicity studies accepted by EPA (1984c). Although these results show that atrazine must be viewed as mutagenic at high levels of exposure, the degree of hazard to humans from low levels of exposure would be minimal.

Bromacil

According to EPA (1982) in a letter to E.I. DuPont De Nemours Co., Inc. dated September 30, 1982, EPA has sufficient data to characterize the mutagenicity of bromacil. According to DuPont De Nemours Co., Inc. in their comments on the Draft of this document (DuPont, 1986), EPA considers bromacil to be nonmutagenic. DuPont states that in studies conducted by non-DuPont laboratories, bromacil has been reported to be nonmutagenic in 5 of 6 point/gene mutation studies, 6 of 6 primary DNA damage studies, and 3 of 4 tests for chromosomal effects.

2,4-D

Mutagenicity studies on 2,4-D have indicated negative, weakly positive, and positive results for various test systems. Newton and Dost (1981) concluded that 2,4-D may be a weak mutagen but that it is "without significance as an environmental mutagenic hazard." EPA has requested additional data to evaluate the mutagenic potential of 2,4-D in mammalian test systems. The worst case assumption is that 2,4-D is mutagenic.

2,4-DP

A limited assessment of the genotoxicity of 2,4-DP is available. 2,4-DP was nonmutagenic when tested in three nonactivated microbial assays (EPA, 1984f). 2,4-DP was not mutagenic in the Ames test. A bacterial assay was positive for induction of repairable DNA damage with metabolic activation. Positive results were obtained when 2,4-DP was tested in two studies with yeast and a bacterial assay for unscheduled DNA synthesis (EPA, 1984f).

Based on the above data, it cannot be presumed that there is mutagenic hazard because in vitro or submammalian assays are inappropriate for hazard assessment. Based upon the inconsistent genotoxic responses and the positive oncogenic effects observed in a chronic oncogenic feeding study of rats, the worst-case assumption is that 2,4-DP is mutagenic.

Dalapon

There are no validated mutagenic data on dalapon. The Environmental Protection Agency has initiated a data call-in including mutagenicity testing for a reassessment of the reregistration of dalapon (EPA, 1984g). Dalapon is probably not a mutagen because a 2-year rat feeding study resulted in no oncogenic effects (USDA, 1984). However, the worst-case assumption is that dalapon has the potential to cause mutagenic effects.

Dicamba

Dicamba was nonmutagenic when tested in various microbial assay systems and a dominant lethal assay with mice (USDA, 1984). It is concluded that dicamba is nonmutagenic.

Diuron

There are no validated mutagenic studies on diuron. EPA has requested additional studies in this area. DuPont has submitted four mutagenicity studies to EPA for the reregistration of diuron. According to DuPont, diuron was nonmutagenic when exposed to a microbial assay, an in vitro mammalian cell assay, and the unscheduled DNA synthesis assay. Diuron induced chromosome aberrations in an in vivo mammalian assay (DuPont, 1986). Diuron was shown to be nononcogenic in a long-term study; therefore it is not likely to be mutagenic. However, the worst-case assumption is that diuron has the potential to produce mutagenic effects.

Fosamine

Fosamine was nonmutagenic when tested in bacterial assay systems, a cytogenetic assay using mammalian cells in vivo, and a DNA assay using mammalian cells in vitro (Schneider and Kaplan, 1983, as cited in USDA, 1984). Chromosome damage was induced by fosamine in an in vitro chromosome assay with rodent cells (Schneider and Kaplan, 1983, in USDA, 1984). Overall, fosamine is considered nonmutagenic and presents no mutagenic hazard to humans.

Glyphosate

Glyphosate was nonmutagenic in microbial assays and mammalian cell assay systems both in vitro and in vivo (EPA, 1984k). There is no evidence to indicate that it is mutagenic or presents any mutagenic risk to humans.

Hexazinone

Negative results were obtained from five of six mutagenicity test systems. Hexazinone was nonmutagenic in Ames assays, an in vitro mammalian cell assay, an assay of unscheduled DNA repair synthesis in mammalian somatic cells, and a mammalian cytogenetic assay (EPA, 1984l; USDA, 1984). Hexazinone was positive for inducing chromosome damage in an in vitro cytogenetic assay with rodent cells (USDA, 1984). This positive effect was observed only at very high levels and could be caused by a secondary effect, such as high ionic concentrations or pH. Based on these results, hexazinone is determined not to present mutagenic hazard to humans.

Picloram

Picloram was nonmutagenic in microbial assay systems and in the rat in vivo cytogenetic assay (USDA, 1984, and EPA, 1984m). Picloram was mutagenic in one assay on a previously untried system (USDA, 1984). The test used has not been validated for use in the standard battery of tests for mutagenicity. EPA has determined that the positive study was insensitive and not capable of determining mutagenicity in the test system. There is no evidence to conclude that it presents a mutagenic risk to humans. EPA has requested additional picloram mutagenicity studies. The worst-case assumption is that it is a mutagen.

Simazine

None of the available mutagenicity studies have been validated by EPA (EPA, 1985d). Simazine was negative for mutagenicity when tested in microbial assay systems and in an in vitro mammalian DNA assay (USDA, 1984). A weakly mutagenic response and an increase in dominant lethals resulted from two studies with the fruit fly (USDA, 1984). This indicates that simazine may be mutagenic in some test systems and that it is a potential mutagenic hazard to humans.

Tebuthiuron

Tebuthiuron tested negative in one mutagenicity assay with bacteria and was weakly positive in a mammalian somatic cell test (EPA, 1985d). Tebuthiuron was nononcogenic in long-term laboratory studies and therefore is probably not a human mutagen. However, the worst-case assumption is that tebuthiuron does have potential to cause mutagenic effects.

Triclopyr

Triclopyr was nonmutagenic in microbial assay systems and in a dominant lethal study using mice. A dominant lethal assay with rats was weakly mutagenic (USDA, 1984). Triclopyr may be mutagenic in some test systems, and is considered a potential human mutagen in this risk assessment.

CARCINOGENICITY OF THE 16 HERBICIDES

The following discussion summarizes the results of cancer tests and other chronic tests that have been used to determine whether any of the 16 herbicides are carcinogenic. Table H-5 presents a summary listing of those results derived from chronic studies.

For those herbicides that have had extensive cancer testing or for which there is scientific controversy concerning the results of one or more cancer studies, the details of the cancer testing are presented in Attachment A. The next subsection on cancer potency summarizes the results of the analysis of tumor data on the six herbicides that have tested positive in at least one cancer study: amitrole, atrazine, 2,4-D, 2,4-DP, glyphosate, and picloram.

Amitrole Carcinogenicity

The many lifetime laboratory animal feeding studies on amitrole have consistently demonstrated its oncogenic potential. In feeding studies using rats, the thyroid and pituitary were the primary target organs at doses as low as 1/20 ppm amitrole (Food Drug Research Lab, 1981, as cited in EPA, 1985a). In mice, amitrole's oncogenic potential has not been as clearly demonstrated because liver and thyroid tumors occurred only when doses exceeded 2,000 ppm (Innes et al., 1969).

In a 2-year study comparing three animal species, doses of 100 ppm amitrole in the diet produced an increased incidence of thyroid tumors in rats but not in mice or hamsters (Steinhoff, 1983, as cited in EPA, 1985a). In addition, positive results in mice and hamster in vitro cell transformation studies have demonstrated amitrole's carcinogenic potential. Based on the available evidence, EPA has classified amitrole as a "probable human carcinogen." The epidemiological studies on humans do not qualify as "at least limited evidence of carcinogenicity to humans" because the authors' follow-up evaluation is entirely inconclusive. Thus, a higher classification is not warranted (EPA, 1985a). An analysis of its cancer potency is given in the next subsection.

Table H-5
Summary of Mutagenicity and Carcinogenicity of Pesticides

Herbicide	Mutagenicity	Oncogenic Results from Chronic Studies
Amitrole	Nonmutagenic 63/69 assays (USDA, 1984) Amitrole does not present potential for heritable genetic effects (EPA, 1985a)	A probable human carcinogen (EPA, 1985a)
Asulam	Nonmutagenic in 1 assay (EPA, 1984b)	Oncogenic in 1 study (EPA, 1985d). Nononcogenic at HDT in 2 studies (EPA, 1984b)
Atrazine	Mutagenic in 19/38 assays (USDA, 1984)	Oncogenic in 1/3 studies (EPA, 1984c; EPA 1986)
Bromacil	Not considered mutagenic by EPA. Existing studies adequate (EPA, 1982). Nonmutagenic in 14/16 assays (DuPont, 1986)	Oncogenic in 1/2 studies (EPA, 1984d; EPA, 1985e)
2,4-D	Nonmutagenic in 28/43 assays (USDA, 1984)	Nononcogenic in 3 studies (EPA, 1984e; Hazleton Laboratories, 1986); scientific uncertainty (Rueber, 1979, as cited in BLM, 1985); oncogenic in 1 study, preliminary findings (EPA, 1986c)
2,4-DP	Nonmutagenic in 4/8 assays (EPA, 1984f)	Oncogenic in 1/2 studies (EPA, 1984f)
Dalapon	No studies reported (EPA, 1984g; USDA, 1984)	Nononcogenic in 2 studies (USDA, 1984)
Dicamba	Nonmutagenic in 6/8 assays (USDA, 1984)	Nononcogenic in 2 studies (EPA, 1984h); studies not adequate according to EPA (EPA, 1985d); nononcogenic in 1 study (EPA, 1986a)

Table H-5 (Cont.)

Herbicide	Mutagenicity	Oncogenic Results from Chronic Studies
Diuron	No studies reported (EPA 1984i; USDA, 1984)	Nononcogenic in 2 studies (EPA, 1984i); Studies not adequate according to EPA (EPA, 1985d).
Fosamine	Nonmutagenic in 4/5 assays (USDA, 1984)	No chronic studies available. (EPA, 1984j; USDA, 1984)
Glyphosate	Nonmutagenic in 7 assays (EPA, 1984k)	Nononcogenic in 1 study at HDT (EPA, 1984k); possibility of weak oncogenic effect in mouse study (EPA, 1985d); scientific uncertainty (EPA, 1986c)
Hexazinone	Nonmutagenic in 4/5 test systems (USDA, 1984)	Nononcogenic in 2 studies (EPA, 1984l)
Picloram	Nonmutagenic in 9/10 assays (USDA, 1984)	Oncogenic in 1/2 studies (EPA, 1984m)
Simazine	Nonmutagenic in 12/14 studies, (USDA, 1984)	Nononcogenic in 1 study (EPA, 1984n)
Tebuthiuron	Nonmutagenic in 1/2 studies, (EPA, 1985d)	Nononcogenic in 1 study (USDA, 1984b)
Triclopyr	Nonmutagenic in 4/5 bacterial and cytogenetic assays (USDA, 1984; EPA, 1985d)	Nononcogenic in 3 studies (USDA, 1984)

Asulam Carcinogenicity

Asulam was carcinogenic in one of the three oncogenicity studies conducted. No oncogenic effects were observed at doses of asulam up to 5,000 ppm (750 mg/kg/day), the highest dose tested, in two 18-month mouse oncogenicity studies (EPA, 1984b). A statistically significant increase in thyroid cell carcinomas was observed in a rat study at 1,000 ppm (20 mg/kg/day) (EPA, 1985d).

Atrazine Carcinogenicity

Available data suggest that atrazine may be carcinogenic. In an 18-month mouse feeding study, atrazine did not induce any tumors at 12.5 mg/kg/day (Innes et al., 1969).

A 2-year oncogenic feeding study of rats resulted in a significant increase in mammary tumors upon exposure to the dosage levels of 70, 500, and 1,000 ppm (3.5, 25, and 50 mg/kg/day). Based on the occurrence of mammary tumors in female rats, atrazine appears to be carcinogenic in rats (USDA, 1986a). Atrazine's cancer potency is discussed in the next section.

A formulated mixture of atrazine and simazine (Fogard-S) injected into mice produced malignant tumors of the lymph glands (Donna et al., 1981). However, because there were many flaws in this study and it is not possible to distinguish what caused the tumors, this study is not considered substantive evidence for carcinogenicity in atrazine. In addition, there is no reason to conclude that a carcinogenic nitrogen derivative of atrazine, N-Nitrosoatrazine (NNA), would be formed in toxic quantities in exposure of humans to atrazine. Details concerning Fogard-S and NNA are given in Attachment C.

Bromacil Carcinogenicity

Bromacil was carcinogenic in one of two oncogenicity studies conducted. No oncogenic effects were observed in rats as a result of exposure to bromacil for a 2-year test period (EPA, 1984d). EPA considers bromacil a liver carcinogen in CD-1 mice. Liver tumors in mice were observed at 5,000 ppm (750 mg/kg/day) after 18 months of exposure (EPA, 1985e).

2,4-D Carcinogenicity

A number of studies have assessed the carcinogenicity of 2,4-D, and thus far, there are no conclusive data demonstrating the carcinogenicity of 2,4-D (International Agency for Research on Cancer, 1977; Mullison, 1981; State of Minnesota, 1978, all as cited in USDA, 1984). However, there is also general agreement that none of these studies were adequate (EPA, 1982a; International Agency for Research on Cancer, 1977, as cited in USDA, 1984; WHO, 1984). At least one scientist, Dr. M. Rueber, disputes the conclusion that a carcinogenic effect of 2,4-D has not been shown. A preliminary review of the most recent cancer study by EPA indicates positive evidence of cancer in rats (EPA, 1986c).

At 106 weeks, a preliminary report from a recent mouse study found that 2,4-D was not oncogenic at dosages of 1, 15, and 45 mg/kg/day (Hazleton Laboratories, 1986). An epidemiology study found no association between exposure and soft-tissue sarcoma or Hodgkin's disease in men exposed to agricultural herbicides, but observed a significant association for non-Hodgkin's lymphoma and phenoxyacetic acid herbicide exposure, especially 2,4-D acid exposure (Hoar et al., 1986). Details of these studies are given in Attachment A. In view of the uncertainties of 2,4-D carcinogenicity, 2,4-D was assumed to be carcinogenic in this risk assessment.

2,4-DP Carcinogenicity

Available evidence indicates that 2,4-DP is carcinogenic in rats (EPA, 1982b). A 2-year feeding study with rats showed tumor formation occurred at doses as low as 25 mg/kg/day (EPA, 1984f). At all doses tested (25, 50, or 150 mg/kg), malignant tumors were induced in test animals. Another study using mice as the test species showed no oncogenic effects at the highest dose tested (300 mg/kg/day) (EPA, 1984f). 2,4-DP is assumed to be a human carcinogen for the purposes of this analysis, and a risk assessment is presented in Section 4. 2,4-DP's cancer potency is discussed in the next subsection.

Dalapon Carcinogenicity

Available data do not indicate that dalapon is carcinogenic. In a 2-year rat feeding study (Paynter et al., 1960 as cited in USDA, 1984) and a 52-week dog feeding study (Paynter et al., 1960 as cited in USDA, 1984), histology sections of test animal tissues revealed no abnormal pathology or evidence of tumor formation resulting from exposure to dalapon (USDA, 1984).

Dicamba Carcinogenicity

Available evidence does not indicate that dicamba is carcinogenic. A 2-year rat feeding study resulted in the absence of any toxic or oncogenic effects of dicamba at 500 ppm (25 mg/kg/day) (HDT). This study is graded as supplementary data by EPA (EPA, 1984h). No oncogenic effects were reported in a 2-year dog feeding study (EPA, 1984h). EPA has requested additional cancer studies for dicamba because the available studies are not considered adequate for defining the oncogenic potential of dicamba based on EPA guidelines under FIFRA (EPA, 1985d). A recent 2-year rat study accepted by EPA (1986a) showed no oncogenic or systemic effects at the highest dose tested (2,500 ppm).

Diuron Carcinogenicity

Available evidence does not indicate that diuron is carcinogenic. At levels as high as 2,500 ppm, there was an absence of oncogenic effects in test animals exposed to diuron (Hodge et al., 1967; DOE, 1983). EPA has requested additional cancer studies on diuron to adequately determine the cancer potential of diuron under the current FIFRA guidelines.

Fosamine Carcinogenicity

Available evidence does not indicate that fosamine is carcinogenic. In a 6-month dog feeding study no oncogenic effects were observed (Schneider and Kaplan, 1983, in USDA, 1984). A 90-day rat feeding study showed no oncogenic effects (Schneider and Kaplan, 1983, in USDA, 1984). Neither the dosage levels administered nor the dosage levels at which toxic effects occurred were reported in 2-year feeding studies to evaluate the oncogenic potential of fosamine.

Glyphosate Carcinogenicity

A 26-month rat feeding study found no oncogenic effects at doses up to 31 mg/kg day (EPA, 1984k). However, this study has been downgraded to supplementary by EPA because the maximum tolerated dose (MTD) was not reached at the high dose. Kidney tumors were found at a high dose level in male mice in a glyphosate cancer study. However, the EPA Science Advisory Panel has reviewed all relevant data and concluded there is not sufficient evidence to conclude that glyphosate is oncogenic in the mouse (EPA, 1986b).

Although EPA has not concluded that glyphosate is a carcinogen based on the available data, for the purposes of this risk analysis, a worst-case assumption is made that glyphosate is a carcinogen, and a risk assessment was conducted. EPA's position on glyphosate's carcinogenicity is presented in Attachment A. Glyphosate's cancer potency is discussed in the next subsection and in Attachment A.

A carcinogenic nitrogen derivative of glyphosate, N-Nitrosoglyphosate (NNG), is not considered a potential human hazard here because NNG is not likely to form in soils at the application rates used in forestry. Details concerning NNG are presented in Attachment A.

Hexazinone Carcinogenicity

Available evidence does not indicate that hexazinone is carcinogenic. In 2-year mouse and rat feeding studies no oncogenic effects of hexazinone were observed at any of the doses tested (200, 1,000, and 2,500 ppm in rats, and at the testing levels of 200, 2,500, and 10,000 ppm in mice) (EPA, 1984l).

Picloram Carcinogenicity

There has been disagreement among experts on the interpretation of studies about the potential of picloram to cause cancer. A rat oncogenicity study, in which test animals were exposed to an average of 14,875 ppm (743 mg/kg/day), was negative for oncogenic effects in males. However, liver tumors were observed in females (EPA, 1984q). A mouse oncogenicity study showed no tumor formation at dietary exposure levels ranging from 5,000 to 15,000 ppm (750 mg/kg to 2,250 mg/kg) (EPA, 1984q). Because of the positive female rat results, a cancer risk analysis has been conducted on picloram in this risk assessment under the assumption that picloram is carcinogenic.

Simazine Carcinogenicity

A chronic study conducted on simazine did not indicate that simazine is carcinogenic (Donna et al., 1981). EPA has requested additional data to assess the possible carcinogenicity of simazine.

The study on the atrazine-simazine mixture (Fogard-S) described above is not considered substantive evidence of the carcinogenicity of either of the constituents. Attachment A presents the details of that study.

Tebuthiuron Carcinogenicity

Available evidence does not indicate that tebuthiuron is carcinogenic. No carcinogenic effects were observed in a chronic feeding study in which rats and mice were fed from 0 to 1,600 ppm tebuthiuron in their diets for 2 years (Elanco Products Co. as cited in USDA, 1985b).

Triclopyr Carcinogenicity

Available data do not indicate that triclopyr is carcinogenic. For both rat and mouse 2-year feeding studies (Dow Chemical Company, 1983b, in USDA, 1984) and a 228-day dog feeding study no oncogenic effects occurred in test animals exposed to triclopyr.

CANCER POTENCY

This subsection presents the results of the cancer potency analysis for each of the herbicides assumed to be carcinogenic in this risk assessment. (See Attachment A for details of this analysis.) The cancer potency value is used later in the risk analysis to determine the human cancer risk under specified assumptions about lifetime human exposure.

The cancer potency of a chemical is defined as the increase in likelihood of getting cancer from a unit increase in the dose of the chemical. This relationship is illustrated by the graph of Figure H-3. The line specifies what the increase in cancer probability is for each unit increase in dose in mg/kg/day.

The cancer potency is derived from tumor data generated in laboratory animal studies. Note in Figure H-3 that the dose levels used in the laboratory cancer studies are high but those liable to be experienced by humans through exposure in the environment are low. Note also that the line relating dose to cancer probability approximates a straight line in the low dose region.

Several aspects of this analysis make the cancer potency estimates very high (pessimistic). First, it is assumed that any dose, no matter how small, has some probability of causing cancer. This is the nonthreshold property, discussed previously, indicating that even a single, extremely small dose may be enough to trigger cancer. Amitrole, for example, has been shown to cause cancer in test animals only at relatively high doses. EPA recommends using a threshold approach to analyze amitrole's carcinogenicity, but this analysis uses the nonthreshold assumption for all seven herbicides.

Second, one of the principal areas of scientific controversy in cancer risk assessment is in extrapolating from the high doses used in animal studies to the far lower doses humans may get. Models other than the one-hit model, which assumes a straight line at low doses as illustrated in Figure H-3, have been used for the extrapolation of cancer data to assess human risk. However, the one-hit model used in this analysis gives the highest estimate of cancer potency and, in turn, cancer risk at the low doses liable to be seen in exposed humans.

Third, the cancer potency used in the calculation of human risk in this analysis is not the expected potency value, but the upper limit value of the 95-percent statistical confidence interval. Using this upper limit value gives a potency that is approximately twice as high as the expected potency estimate. The details of the cancer potency derivation for all of the chemicals based on the one-hit model are given in Attachment A.

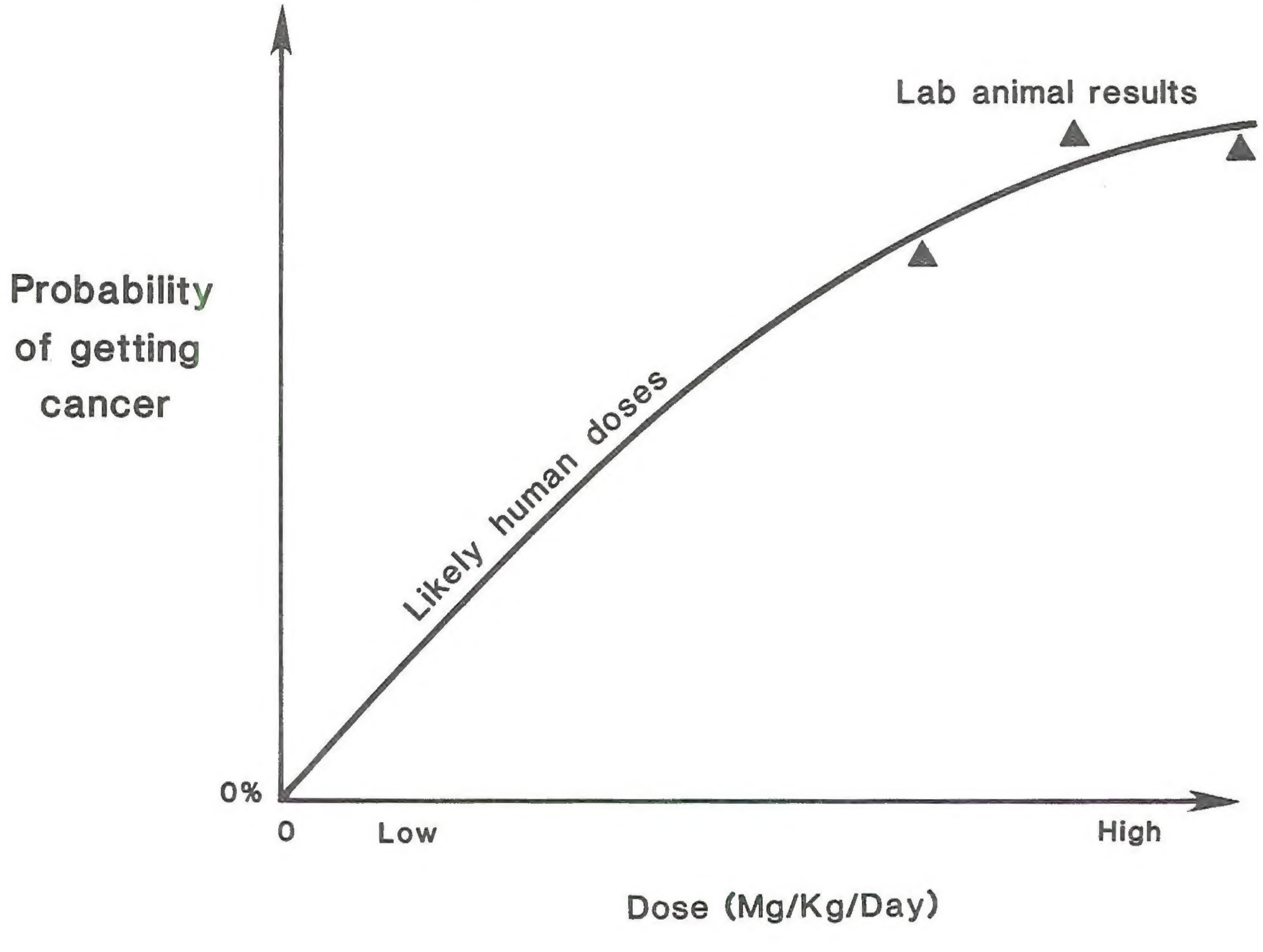


Figure H-3 Cancer Potency Curve

Amitrole Cancer Potency

Amitrole cancer potency was estimated using data from three studies:

1. A 2-year rat feeding study conducted by Hazleton Laboratories, Inc.
2. A study by Tsuda et al. (1976) in which rats were given 2,500 ppm in their drinking water.
3. A study by Food and Drug Research (1981, as cited in EPA, 1985a) in which rats alternately were fed food with and without amitrole.

The cancer potency for amitrole estimated from the Hazleton Labs rat study data was 0.15 per (mg/kg/day). The data of Tsuda et al. (1976) gave a potency of 0.011 per (mg/kg/day) for all invasive thyroid lesions and 0.00098 per (mg/kg/day) for papillary adenoma. The Food and Drug Research 1981 study (as cited in EPA 1985a) indicated a cancer potency for thyroid tumors of 0.61 (considering only the intermittently dosed groups). In this risk assessment, the highest of these potencies is used to estimate human cancer risk. The 95-percent upper confidence limit for the potency based on the Food and Drug Research data is 1.4 per (mg/kg/day).

Asulam Cancer Potency

Asulam cancer potency was based on the rate of tumor formation in thyroid cells in male rats in a 107-week feeding study (EPA, 1983). The cancer potency using the one-hit model is 0.02 per (mg/kg/day).

Atrazine Cancer Potency

Atrazine cancer potency was calculated based on the rate of mammary tumor formation in female rats in a 2-year chronic feeding oncogenicity study (EPA, 1986). The cancer potency estimated using the single hit cancer model is .03 per (mg/kg/day) (USDA, 1986a).

Bromacil Cancer Potency

Bromacil cancer potency was based on the rate of liver tumor formation in male mice in an 18-month feeding study. The cancer potency estimated from the one-hit model is 0.0038 per (mg/kg/day) (EPA, 1985e).

2,4-D Cancer Potency

2,4-D cancer potency was calculated based on the rate of tumor formation in the female Osborne-Mendel rats studied by Hansen et al. (1971). This is the species and sex that have exhibited the highest increase in tumor formation after 2,4-D administration. All tumors were considered, although many of them were benign. As in the case of amitrole, the conservative one-hit model was used to represent the relationship between dose and rate of tumor formation. The 95-percent upper confidence limit of the cancer potency, calculated by Crump (1983) using the GLOBAL 82 computer program, was 0.00503 per (mg/kg/day). (EPA has stated that a preliminary review of an additional long-term oncogenicity study submitted to EPA in 1986 indicates that the cancer potency level would be of about the same magnitude as the cancer potency calculated by Crump (EPA, 1986)).

2,4-DP Cancer Potency

A cancer study involving rats fed up to 200 mg/kg (EPA, 1982b) was used to derive 2,4-DP cancer potency. In this study, the highest dose group showed signs of general toxicity because they were fed more than the maximum tolerated dose of 2,4-DP. Many of the females at all dose levels had tumors but they did not show a dose-related response. Males showed a significant increase in the rate of incidence of malignant tumors, with a corresponding decrease in the rate of benign tumors. The tumors were primarily in the thyroid and pituitary glands.

The 95-percent upper confidence limit for the cancer potency of 2,4-DP was estimated from the male rat data as 0.059 per (mg/kg/day). Only malignant tumors were considered in this case, and the high dose group showing signs of general toxicity was not considered in order to give the highest cancer potency indicated by the data. The high dose group actually had fewer malignant tumors than the intermediate dose group.

Glyphosate Cancer Potency

Glyphosate cancer potency was based on the rate of kidney tumor formation in male mice in the feeding study reported in EPA (1985b).

The upper 95-percent limit of the cancer potency of glyphosate calculated from the kidney tumor data was 0.000034 per (mg/kg/day).

Picloram Cancer Potency

The Gulf Research Institute conducted a carcinogenic bioassay of picloram in rats and mice for the National Cancer Institute (1978). There was evidence that picloram affected the livers of male and female rats, and the study concluded that the findings were "suggestive of ability of the compound to induce benign tumors in livers of female Osborne-Mendel rats."

Using the one-hit model, a 95-percent upper confidence limit on picloram carcinogenicity has been calculated by Crump (1983) using the GLOBAL 82 computer program. His estimate is 0.00057 per (mg/kg/day). This is only about one-tenth as great as that for 2,4-D.

INERT INGREDIENTS

Inert ingredients are chemicals used with the active ingredient in preparing a formulation of a herbicide. Inert ingredients are used to provide a carrier for the active ingredient that facilitates the effective application of the herbicide. Inerts are not intended to supplement the herbicide's toxic properties.

EPA's Office of Pesticide Programs (EPA 1986d) has identified about 1,200 inert ingredients that are now used in approved pesticides and has reviewed the existing evidence concerning the toxicity of these inerts, including laboratory toxicity data, epidemiological data, and structure/activity relationships. Of particular concern in reviewing the inerts was their potential for causing chronic human health effects. The EPA review resulted in categorizing the 1,200 inerts into four lists.

List 1 contains about 55 inerts that have been shown to be carcinogens, developmental toxicants, neurotoxins, or potential ecological hazards and that merit the highest priority for regulatory action.

List 2 contains approximately 50 chemicals that have been given high priority for testing because toxicity data are suggestive, but not conclusive, of possible chronic health effects or because they have structures similar to chemicals on List 1.

List 3 contains about 800 chemicals that are of lower priority because no evidence from toxicity data or from a review of their chemical structure would now support a concern for toxicity or risk.

List 4 of about 300 chemicals contains those inerts generally recognized as safe.

Because EPA normally classifies inert ingredients as "Confidential Business Information," information on them does not have to be released by EPA to the public under the Freedom of Information Act (see also 40 CFR 1506.(a)). Nonetheless, the BLM requested that the EPA review the herbicides proposed for use, and disclose whether any of them contained inert ingredients of or suggesting toxicological concern. EPA has completed this review for some of the chemical formulations and is currently reviewing the remaining formulations. EPA will inform the BLM when the review is complete.

The EPA so far has identified only one inert ingredient on either list 1 or list 2. This ingredient, contained in Esteron 99, Weedone 2,4-DP, Weedone 170, and Garlon 4, is a petroleum distillate of high priority for testing. Accordingly, a risk analysis has been conducted on the human health risk from exposure to the petroleum distillate in these herbicides. The risk analysis also considers risk from exposure to diesel oil, a petroleum distillate used as a carrier for herbicides. Other than these materials, the BLM intends to use only formulations containing inerts that EPA generally recognizes as safe or that do not support a specific concern for toxicity or risk. The BLM does not intend to use any formulations other than those identified containing inert ingredients on list 1 or list 2.

EPA (1987) noted that concerns regarding the acute toxicity of inert ingredients are usually addressed through tests of the herbicides as formulated products. While the herbicides as formulated products have undergone acute toxicity testing, they generally have not undergone extensive chronic toxicity testing, or cancer, reproductive, developmental or mutagenicity tests. The gap is the testing of the herbicides as formulated products, according to one view gives rise to one inference that the environmental consequences, including hazards to human health, from using them are largely unknown, The theory holds that regardless of what is known about each herbicide formulation's two components, that is, the active ingredients and inerts, the possibility exists that the formulated product may pose greater risk than separate consideration of each component may suggest. Given the little information that is available on each herbicide's formulation, the possibility cannot be discounted entirely. Neither can it be presumed as true. The possibility that the herbicides' formulations may pose greater risk than their components is largely an untested hypothesis, and as to the herbicides' formulations acute toxicity, this possibility has not been shown to follow. Turning to the competing viewpoint, and the one adopted in this EIS, the data gaps about the herbicides as formulated products is largely beside the point since the risks posed by the herbicide's active ingredient are over stated. Any risk posed by the herbicides as formulated products is considered to be subsumed by the analysis of the active ingredients. Moreover, it must be recalled that each herbicide as a formulated product contains two types of ingredients: active and inert. Each type of ingredient has known and suspected properties. The herbicides' active ingredients have undergone cancer, reproductive, developmental, and mutagenicity tests of varying degrees. The herbicides' inerts have undergone categorization according to their toxicity and risks, if any. With only one lone exception, no specific concern exists with the herbicides' inerts. Thus, because the herbicides' active ingredients here, not their inerts, pose the risks, it logically follows that any analysis drawing attention to the former as opposed to the latter is properly focused.

An analysis of the hazard of the inert ingredient of toxicological concern and diesel oil now follows.

Esteron, Weedone 2,4-DP, Weedone 170, and Garlon 4 contain petroleum distillates as inert ingredients. The toxicity of the petroleum distillates can be estimated from the toxicity of diesel.

Diesel oil is a complex variable mixture of hydrocarbons with a boiling point range of from 350° to 700° F and an aromatic content ranging up to 35 percent (DOE 1983). Diesel fuel is usually a straight-run distillation product that boils below 650° F, contains few polycyclic aromatics, and has not been shown to be carcinogenic. A 2-year oncogenic skin-painting study (terminated after 62 weeks), during which Swiss Epley mice were exposed to 0.05 mL (41 mg) of diesel fuel products, resulted in skin carcinomas in 2 of 50 animals. These results were not statistically significant by chi-square analysis. The study was prematurely terminated because of the presence of extensive skin lesions in test animals (American Petroleum Institute 1983). Higher boiling point (greater than 700° F) petroleum products subjected to more refinement processes, such as cracking or hydrogenation, and that contain polycyclic aromatics may be carcinogenic to experimental animals (Bingham and others 1979).

Beck and others (1982) conducted a short-term exposure study examining the acute toxicity of 19 petroleum hydrocarbons in acute oral, acute dermal, subacute dermal, and eye irritation studies. On the basis of an acute oral LD_{50} of 9.0 mL/kg (7,380 mg/kg), diesel oil can be classified as a very slightly toxic compound. The LD_{50} is about 20 times greater than that of 2,4-D. The most marked acute toxic effect observed after the administration of oil to test animals occurred during diesel primary dermal irritation studies. A single diesel oil exposure to rabbits resulted in a rating of "extremely irritating" based on a score of 6.82 (on a scale of 1 to 10). Irritation may have been caused by chemical additives used to make diesel oil burn more efficiently in internal combustion engines. Diesel oil was nonirritating in primary eye irritation studies. A subacute 3-week dermal study of eight rabbits resulted in an average weight loss of 0.38 kg at a dose level of 4.0 mL/kg (3,280 mg/kg) and an average weight loss of 0.55 kg with a 67-percent mortality rate at a dose level of 8.0 mL/kg (6,560 mg/kg).

An inhalation teratology study in which rats were exposed to 101.8 ppm or 401.5 ppm (5.09 or 20.075 mL/kg) of diesel fuel on days 6 through 15 of gestation resulted in no significant teratogenic effects (Mecler and Beliles 1979 as cited in American Petroleum Institute 1983). Diesel fuel was nonmutagenic when tested in the Ames assay and the mouse lymphoma assay, but it was found to be clastogenic (causing chromosomal breaks) in rat bone marrow cells (Conaway and others 1982). Because diesel oil contains polycyclic aromatic hydrocarbons and other constituents that are known or suspected mutagens, this risk assessment considered it a mutagen as a worst-case assumption.

Diesel oil has not been shown to be carcinogenic, but it is a complex mixture that typically contains small amounts of substances known or suspected of being carcinogenic. For the purposes of this risk assessment, diesel oil is assumed to be carcinogenic because of its benzene content and its content of polycyclic aromatic hydrocarbons, typified by the potent carcinogen benzo(a)pyrene. But these carcinogens occur in such small amounts that they do not contribute significantly to the potency calculated for 2,4-D. Consequently, cancer risk was not calculated separately for petroleum oil but only for the total mixture with 2,4-D.

The oncogenic potential of petroleum fuels is directly related to refinery processing methods used to obtain the petroleum product and the crude oil composition from which the fuel was derived. An evaluation of the composition of petroleum fuels has revealed a positive correlation between polycyclic aromatic hydrocarbon (PAH) content and carcinogenicity in human epidemiology studies or experimental laboratory studies (Bingham and others 1979).

Substances known or suspected of being carcinogenic and contained in diesel oil in small amounts include benzo(a)pyrene and benzene. Benzo(a)pyrene (BaP), a potent carcinogen, is a PAH that also occurs at low levels in foods and in products of combustion, including cigarette smoke. Bioassays have found that the concentration of this single carcinogen can often serve as a guide in predicting carcinogenic potency, although other substances are also known to be involved (Bingham and others 1979).

There is sufficient evidence for the carcinogenicity of BaP in experimental animals: BaP has produced tumors in all of the nine species for which data have been reported following various methods of administration (DHHS 1985). It has both a local and systemic carcinogenic effect. EPA (1986e) has estimated the carcinogenic potency of BaP as 11.5 per mg/kg/day.

For benzene, another aromatic known to be present in diesel fuels, sufficient evidence exists for its carcinogenicity in experimental animals and in humans (DHHS 1985). Benzene has been shown to cause leukemia in workers with chronic exposure. The carcinogenic potency of benzene, however, is much less than that of BaP. EPA (1986f) has estimated the carcinogenic potency of benzene as 0.0445 per mg/kg/day. But benzene can occur at greater concentrations (about 29 ppm in No. 2 fuel oil) than BaP occurs in diesel oil. Consequently, the carcinogenic potencies of diesel oil have been estimated for this EIS on the basis of the potencies of both benzene and BaP.

The cancer potency of diesel oil and the petroleum distillates in the herbicides was estimated from the potencies of both benzene and benzo(a)-pyrene. Samples of diesel oil and fuel oil have been found to have a BaP content of only 26 ppb, but No. 2 heating oil (which may be subjected to cracking rather than straight-run distillation) can contain 600 ppb (Bingham and others 1979). The midpoint of this concentration range--313 ppb--has been used to calculate the carcinogenic potency of the petroleum distillates although most diesel fuels can be expected to have lower BaP contents. The content of benzene was assumed to be 28.5 ppm on the basis of an analysis of water extracts of No. 2 fuel oil by Anderson (1975), with corrections for solubility relationships. The resulting estimate of carcinogenic potency of the diesel oil carrier and the petroleum distillates is 4.9×10^{-6} $(mg/kg/day)^{-1}$. Seventy-four percent of this potency is due to the BaP component. Because this potency is about one thousandth of that of 2,4-D and one hundredth of 2,4-DP, it would not add significantly to the potency of the 2,4-D or 2,4-DP mixtures.

Table H-6
Brand Names of Herbicides Proposed for Use[1/]

Herbicide	Brand Name	EPA Registration Number
Amitrole	Amitrole T	264-135
	Amino Triazole	264-68
Asulam	Asulox	359-662
Atrazine	Drexel Atrazine 80	19713-6
	AAtrex 80W	100-439
Bromacil	Hyvar X	352-287
	Hyvar XL	352-346
2,4-D	DMA4	464-196
	Esteron 99C[2/]	464-566
	Esteron 6E[2/]	464-347
	Formula 40	464-001
2,4-DP	Weedone 2,4-DP [2/]	264-231
	Weedone 170 [2/]	264-222
Dalapon	Dowpon M	464-402
Dicamba	Banvel	55947-1
Diuron	Drexel Diuron 80	19713-21
Fosamine	Krenite	352-376
Glyphosate	Rodeo	524-343
Hexazinone	Velpar L	352-392
	Pronone 10G	33560-21
Picloram	Tordon 22K	464-323
	Tordon 101R	464-510
Simazine	Drexel Simazine 80	19713-46
	Princep 80W	100-437
	Princep 4G	100-435
Tebuthiuron	Spike 80W	1471-97
	Spike 20P	1471-123
	Spike 40P	1471-124
	Spike Brush Bullets	1471-129
Triclopyr	Garlon 3A	464-546
	Garlon 4 [2/]	464-554

[1/] These products contain no inert ingredients (except for those under 2/) of concern for toxicity as identified on EPA's Lists 1 and 2. Other brands may also be used as long as they too do not have inerts identified on List 1 or 2 by EPA.

[2/] Contains petroleum distillate.

Section 3

EXPOSURE ANALYSIS

INTRODUCTION

This section presents the methods and results of the herbicide exposure analysis. The first subsection contains the basic background information used in defining the exposure analysis methods. The terminology of herbicide use and the potential human exposure from that use are discussed.

The second subsection presents the methods used to estimate herbicide doses to workers and members of the general public. The methods used for determining lifetime doses to workers and the public to evaluate the risk of cancer are described. The second subsection also discusses the populations at risk in the vegetation management programs.

The third subsection gives the results of the routine and accidental dose calculations for workers and the public for each herbicide and the results of the lifetime dose estimation.

Some Helpful Terms

This subsection defines some of the terms used in the discussion of the exposure analysis methods and explains the relationship between the doses estimated in the analysis and the doses that might actually occur in future herbicide treatment operations. Other terms may be found in the Glossary.

Herbicide Characteristics

Most herbicides are packaged and sold by the manufacturer in liquid form as a concentrate with a specified number of pounds of active ingredient, usually between 1 and 10, per gallon of concentrate and with inert ingredients forming the remaining portion. Many of the herbicides also are marketed in the form of wettable powder and granular formulations.

Before herbicides are applied, they are mixed with a carrier, usually water, according to the manufacturer's label instructions for the particular treatment purpose and the desired application rate in pounds of active ingredient per acre. The amount of concentrate that produces the desired amount of active ingredient per acre treated normally is mixed with 10 to 15 gallons of carrier for every acre to be treated in aerial applications and with 50 to 100 gallons of carrier for every acre to be treated in ground applications. Herbicide concentrate, stored in 30- to 55-gallon drums, is prepared for application and then is transferred to application equipment by a mixer-loader, who uses a batch truck that has separate storage tanks for the carrier and for the herbicide mixture.

Herbicide application equipment is designed to cover the target plants with a minimum of off-target spray movement, called drift. Spray equipment nozzles are designed to produce medium to large droplets because smaller droplets tend to remain airborne and may drift with air currents away from the target vegetation. Despite the effectiveness of the application equipment used, some small fraction of the droplets may break up into smaller droplets that the wind could blow offsite. Hand application techniques, such as injection and hack and squirt, do not use sprays; thus, these techniques do not produce herbicide drift.

Exposure and Dose

Two primary conditions are necessary for a human to receive an herbicide dose that may result in a toxic effect. First, the herbicide must be present in the person's immediate environment so that it is available for intake. It must be in the air the person breathes, on the person's skin, or in the person's food or water. The amount of herbicide present in the person's immediate environment is the exposure level.

Second, the herbicide must get into the person's body by some route. If it is in the air, it may be inhaled into the air passages and lungs. If it is on the clothing or skin, it may penetrate the skin. The amount that moves into the body by any of these routes constitutes the dose.

Thus, although two people may be subjected to the same level of exposure--for example, two workers applying herbicide with backpack sprayers--one may get a much lower dose than the other by wearing protective clothing, using a respirator, or washing immediately after spraying. Exposure, then, is the amount of herbicide available to be taken in; dose is the amount that actually enters the body.

Potential Routes of Human Exposure

The routes of exposure considered in this risk assessment in estimating doses to workers and the public that might occur during routine operations or in the event of an accident are listed in Table H-7 and are described below. Food items and drinking water sources that may lead to ingestion (dietary) exposures are listed in Table H-8.

Potential Human Exposures from Routine Operations

The greatest doses to humans in routine herbicide applications are to workers who may be exposed while: (1) mixing and loading herbicide into application equipment, (2) applying herbicide to vegetation using ground-based equipment, or (3) supervising or monitoring aerial or groundbased herbicide applications. Use of protective clothing and equipment and adherence to proper cleanup procedures and label precautions in general lead to significant reductions in the doses of workers.

The single most important source of exposure to persons who do not handle the herbicide containers or spray equipment in routine operations is from the drift off target of airborne herbicide spray droplets. Spraying only under favorable weather conditions and the use of spray equipment that limits the number of smaller spray droplets reduces the amount and extent of drift.

During routine operations, workers may be dermally exposed to a herbicide if the herbicide concentrate, mixture, or drifting spray droplets contact the skin or if the herbicide is brushed off of sprayed vegetation. Inhalation exposure may result from breathing without protective devices in the

Table H-7

Routes of Exposure Considered in This Risk Assessment

	Doses from Direct Exposure	Doses from Indirect Exposure
Routine		
Workers	Total dose (based on field studies)	Dermal dose from reentry to treated area based on field data
General Public	Dermal dose[a] from drift (based on modeling)	Dermal dose from vegetation contact in drift area and from consuming food with residues[b]
Accidental		
Spraying	Dermal dose[a] to member of public directly sprayed	Worker vegetation contact dose from reentry to treated area immediately after spraying. Dose to member of public who walks through treated area and who eats directly sprayed food items[b]
Spills	Worker dermal dose from spill of concentrate or mixture on skin	Dose to member of public from drinking water contaminated by an herbicide spill

[a] Inhalation is negligible based on field study data.
[b] See Table H-8 for diet items used in dose estimates.

area of the drifting spray droplets or where there are vapors from a volatile herbicide. However, a variety of studies have shown that inhalation exposure is very small compared with dermal exposure. In this analysis, inhalation doses have not been estimated separately for workers; they are included with dermal doses in the estimated total worker doses based on herbicide levels in the urine of workers in field experiments.

Members of the general public who are within the area of drift of the smaller spray droplets may also receive dermal and inhalation exposure, but their exposures are relatively low compared to the exposures of workers

Table H-8

Dietary Exposures Estimated in This Risk Analysis

Scenario	Water	Food Items
Routine		
Realistic	Drift onto pond	Garden vegetables offsite Berries offsite Meat from a deer feeding offsite Meat from a game bird feeding offsite Fish caught in a pond receiving drift
Worst Case	Drift onto pond that is closer than realistic	Food items same as in realistic but closer to treatment unit
Accidental		
Spraying	Pond directly sprayed	Garden vegetables onsite Berries onsite Deer feeding in treated area Fish caught in pond directly sprayed Game bird directly sprayed
Spills	100- or 2,000-gal spill of mix in drinking water supply	

directly involved in the spraying operations. Field studies of workers have consistently shown that inhalation exposure represents only a small part of the total exposure, so doses to the general public in this analysis have been calculated only for dermal and dietary routes (see description of worker studies later in this section).

Herbicide may be ingested by members of the general public from food containing herbicide residues. Food items such as garden vegetables, wild berries, or game animals may have received some level of herbicide from spray drift. Game animals may have fed on plants from the drift area. Ingestion exposure could also result from drinking water that has received herbicide drift or from eating fish from a body of water that has received herbicide drift.

Potential Human Exposures from Accidents

In the event of an accident, workers and members of the public may be exposed to much greater amounts of herbicide than they would under normal circumstances. Workers who spill the concentrate or some of the prepared spray mixture on their skin during mixing, loading, or spraying operations or who are doused when a transfer hose breaks would be dermally exposed. Workers or members of the public who are accidentally sprayed with herbicide because they are beneath a spray aircraft or are too close to a truck or backpack applicator would receive a dermal dose.

The dermal dose would depend on the concentration of herbicide in the spray mix, the area of the sprayed person's exposed skin, the extent to which the person's clothing absorbed herbicide (some clothing is water repellent, but other material would permit penetration of the herbicide to the skin), and the time that elapses before the person can wash. Indirect dermal (reentry) exposure may occur if workers or members of the public brush up against wet vegetation in the sprayed area.

Members of the public may accidentally be exposed to the herbicide by eating food or drinking water that has been directly sprayed. For example, members of the public may eat berries that have been directly sprayed, or they may eat meat from deer that have recently foraged on a sprayed site. Exposure to even higher levels of herbicide is possible if a container of herbicide concentrate were to break open and spill into a drinking water supply.

EXPOSURE ANALYSIS METHODS

Application Scenarios

To make reasonable estimates of the possible herbicide doses to workers and the public, a number of application scenarios are used that represent an array of likely treatment situations. Routine application scenarios were designed to provide a range of human dose estimates, from realistic to worst case, for normal operating conditions. Accidental-worst case scenarios--direct application, spills on the skin, and large spills into bodies of water--are used to estimate the highest doses that could ever be reasonably expected to occur. All but the lowest doses from all vegetation management projects conducted in the Pacific Northwest should fall within the range of doses predicted in these scenarios.

The scenarios specify those characteristics of each kind of herbicide application operation that determine human doses. For example, for workers involved in backpack operations, the number of work hours and the herbicide application rate are used to determine their doses. For aerial applications, the number and size of the sites treated in a day's operation are used. To calculate doses to nearby residents who may eat a garden vegetable containing herbicide residue, it was necessary to estimate how much residue was on the vegetable and to specify how much of the vegetable was eaten.

The application scenarios were not intended to show what necessarily will happen as a result of a given treatment operation, but what could happen if all of the conditions specified in the scenario were met in the actual operations. For example, worker doses are based on actual dose levels found in field exposure studies in which no protective clothing or equipment was worn. If workers were to wear protective clothing and equipment during actual operations, their doses could be significantly lower than those estimated here. However, despite all precautions, workers present during treatment operations will be exposed to some extent.

Additional factors must be recognized when evaluating the likelihood of a member of the public receiving a herbicide dose. A forest user would receive a dose only in the immediate vicinity of the treatment area and only at the time of the herbicide application. However, because of the limited area of forest being treated and the public's restricted access and use, the possibility of this occurrence is slight. Likewise, a nearby resident would receive a dose as high as the one estimated in this analysis from eating garden vegetables with herbicide residue only if all of the following conditions were met:

1. The resident's garden was close enough to a particular treatment area to receive some level of herbicide drift.

2. The weather conditions on the day of treatment were such that the herbicide happened to drift offsite in the direction of the garden.

3. The resident ate the vegetable immediately after the herbicide residue landed on it.

A combination of factors makes the possibility of the resident receiving such a dose highly unlikely. First, most treatment areas are located considerably further from any residence than the distance assumed in this analysis--600 feet. Second, mitigation measures to be used reduce the likelihood of drift onto a garden, even if one happened to be nearby. Third, there is only a small possibility the resident would immediately pick and eat a garden vegetable that had herbicide residue from that operation.

Workers Doses from Routine Operations

Herbicide doses to workers involved in routine operations were estimated using eight herbicide application scenarios: four routine-realistic and four routine-worst case scenarios. For each application scenario, worker categories were chosen to represent the normal range of work activities in terms of potential herbicide exposure. Other categories of workers may experience less exposure, but no category of workers in the field is expected to experience greater exposure than the types of workers considered in this analysis.

Doses to members of the public as a result of routine operations were estimated using three of the routine-realistic and three of the routine-worst case scenarios used to derive the worker doses. Again, other categories of the public may receive less exposure, but no one should receive more under normal operating conditions.

Worker Categories and Calculations in Routine Operations

Worker dose levels were extrapolated directly from worker doses determined by urine analysis in field studies of actual herbicide treatment operations. Because the field studies showed what dose levels are experienced in actual operations, they were considered the most appropriate basis for estimating the doses of BLM herbicide applicators involved in the same or similar vegetation management practices. Those studies are discussed in the next subsection.

Dose estimates were scaled to the anticipated work hours and herbicide application rates specified in each of eight application scenarios.

Routine-realistic. To estimate routine-realistic worker doses, average dose levels found by urine analysis in field studies of workers exposed in spraying 2,4-D using the same application method were used. Nominal dose levels in mg/kg for workers in each category (see below) were derived from these average dose levels by dividing by the field study acreage and application rate.

Application rates for the routine-realistic dose scenarios are listed in Table H-9.

The worker categories and scenarios used for estimating the routine-realistic worker doses included the following:

1. Doses to pilots, mixer-loaders, supervisors, and observers in a helicopter broadcast treatment of four 40-acre silviculture sites;

2. Doses to applicators, mixer-loaders, and applicator/mixer-loaders in truck broadcast spraying of 12 acres (33 feet wide by 3 miles long) of roadway right-of-way;

3. Backpack applicator doses in backpack spraying of a 6-acre facility's maintenance site by two applicators for 6 hours;

4. Doses to applicators using hack-and-squirt and injection-bar methods in hand treatment of 3 acres by two applicators for 6 hours.

Worker doses for each worker category were estimated by extrapolating from the average dose levels found in field studies of workers exposed to 2,4-D using the same application method. The following steps were involved:

1. The average dose observed in the 2,4-D field study was expressed in terms of dose per pound of active ingredient applied.

2. The acreage figure was used to determine the number of pounds of active ingredient used in the scenario by multiplying by the herbicide's typical application rate (listed in Table H-9).

Table H-9

Application Rates Used for
Routine-Realistic and Routine-Worst Case Scenarios
(lb active ingredient/acre)

	Aerial		Backpack		Right-of-Way	
	Realistic	Worst Case	Realistic	Worst Case	Realistic	Worst Case
Amitrole	0.00	0.00	2.00	5.00	2.00	8.00
Asulam	0.00	0.00	1.20	3.34	2.40	5.00
Atrazine	3.75	4.00	3.00	4.00	3.00	8.50
Bromacil	0.00	0.00	4.00	10.00	4.00	10.00
2,4-D	2.50	4.00	2.00	4.00	2.50	4.10
2,4-DP	0.00	0.00	2.00	4.30	2.50	5.00
Dalapon	0.00	0.00	4.00	12.00	4.00	10.00
Dicamba	0.00	0.00	0.50	4.00	1.00	3.60
Diuron	0.00	0.00	4.00	6.00	4.00	16.00
Fosamine	0.00	0.00	3.00	11.50	4.00	10.70
Glyphosate	0.00	0.00	1.50	5.00	2.00	5.00
Hexazinone	2.50	3.00	1.12	3.00	2.50	6.00
Picloram	1.00	5.00	1.00	4.00	1.00	2.00
Simazine	0.00	0.00	2.00	4.60	2.00	4.60
Tebuthiuron	0.00	0.00	1.50	6.00	2.20	4.60
Triclopyr	2.00	8.00	2.00	8.00	2.00	8.00

3. The herbicide-specific dose was determined by multiplying the pounds of herbicide applied by the dose of 2,4-D per pound of 2,4-D applied for that worker category in the field studies and then adjusting for the herbicide's dermal penetration rate. The dermal penetration rates used in the analysis were 6 percent for 2,4-D (Feldman and Maibach, 1974), 6.4 percent for 2,4-DP, 0.48 percent for picloram (Lavy et al., 1984), 5 percent for dicamba (Draper and Street, 1982), 0.1 percent for amitrole, and 10 percent for the other 11 herbicides (USDA, 1984).

The following example illustrates these steps. To calculate an applicator's exposure to dicamba during the Routine-Realistic Right-of-Way operation, the average 2,4-D dose to a sprayer in the Nash et al., 1982 study (Table H-10) of 0.012 mg/kg was divided by the average number of pounds of 2,4-D applied by the spraymen, 70 pounds, to give an estimate of the dose per pound of active ingredient applied, 1.7×10^{-4} mg/kg/lb. The next step was to calculate the total number of pounds of dicamba applied by multiplying the application rate for the scenario (Table H-9) by the total number of acres treated in the operation, 12. For dicamba this would be 1.00 lb/acre x 12 acres = 12 lbs. applied. To calculate the dose, a correction factor was calculated for the difference in dermal penetration rates between dicamba (.05) and 2,4-D (.06), .05/.06 = 0.83. Finally, the dose was calculated as 1.7×10^{-4} mg/kg/lb x 12 lbs. x 0.83 = .0017 mg/kg (see Table B-5).

Routine-Worst Case. Routine-worst case worker doses were estimated for the same worker categories used in the routine-realistic scenarios. However, the site size, application rate, equipment type, meteorological conditions, and duration of exposure were set to those that would lead to the highest levels of exposure in herbicide treatment operations. Herbicide-specific dose levels in the routine-worst case scenarios were again derived from the worker field studies and weighted for application rate and hours exposed, but here the 95 percent upper confidence level of the field study doses was used for extrapolating to the nominal dose in mg/kg/hr for a 1-lb/acre application rate. Application rates used in the routine-worst case scenarios are listed in Table H-9.

The worker categories and scenarios used for estimating routine-worst case worker doses included the following:

1. Doses to pilots, mixer-loaders, supervisors, and observers in fixed-wing broadcast spraying of a 400-acre site for range improvement.

2. Doses to applicators, mixer-loaders, and applicator/mixer-loaders in truck broadcast spraying of 40 acres of transmission line right-of-way.

3. Backpack applicator doses in backpack spraying of a 60-acre conifer release site by 14 applicators for 9 hours.

4. Doses to applicators using hack-and-squirt and injection-bar methods in hand treatment of 9 acres by four applicators for 9 hours.

The following example illustrates the calculation of the applicator's exposure to dicamba during the Routine-Worst Case Right-of-Way operation. First, the upper bound of a 95 percent confidence interval for sprayer doses in the Nash et al., 1982 study was calculated as .0557 mg/kg, and divided by the average number of pounds applied, 70, to estimate the 95 percent upper confidence limit of dose per pound of active ingredient applied: 7.96×10^{-4} mg/kg/lb. Then the number of pounds of dicamba applied in the Routine-Worst Case scenario was calculated by multiplying the application rate (from Table H-9) by the total number of acres treated per day, 40. For dicamba this would be 3.60 lb/acre x 40 acres = 144 lbs applied. To calculate the dose, the correction factor must be used to relate the dermal penetration rate of dicamba (.05) to that of 2,4-D (.06), .05/.06 = 0.83. Finally the dose was calculated as 7.96×10^{-4} mg/kg/lb x 144 lbs. x 0.83 = 0.095 mg/kg.

Field Studies of Worker Exposure to 2,4-D

Field studies of the exposures and resultant doses of workers using a variety of application equipment have been conducted on 2,4-D by Lavy et al., 1982, Lavy et al., 1984, Nash et al., 1982, and Franklin et al., 1982. Doses for each worker category found in the studies are listed in Table H-10. Lavy et al., 1982, monitored three helicopter spray crews for worker exposure to 2,4-D, using portable air filters, denim patches, and urine analysis on two separate spraying dates; the first observing normal

Table H-10
Doses of 2,4-D Measured in Exposure Studies for Each Worker Category

Investigator	Application Type and Rate	Equipment Used	Worker Category	Number of Workers	Method of Analysis	Doses	
						Average	Range
Lavy et al., 1982	Aerial, 2.2 Kg a.i./ha	Helicopter	Flagman	2		--	0.00119-0.00177 mg/kg/day
			Pilot	3	Denim Patches	0.00057 mg/kg	n.d.-0.0010 mg/kg
			Mechanic	3		0.0233	0.0233-0.0617
			Batchman	3		0.0448	0.0233-0.0911
			Supervisor	3		0.0167	n.d.-0.0005
			Observer	6		8×10^{-5}	n.d.-0.0005
			Pilot	3	Urine	0.00248 mg/kg	0.00179-0.0557 mg/kg
			Mechanic	3		0.00068	0.00044-0.0136
			Batchman	3		0.00245	0.00215-0.0377
			Supervisor	3		0.00029	n.d.-0.0069
			Observer	6		0.00006	n.d.-0.0013
	Aerial	Helicopter, Special Precautions: Protective Coveralls, Gloves, Boots, Hats, Goggles	Pilot	3	Denim Patches	3.3×10^{-5} mg/kg	n.d.-0.0001 mg/kg
			Mechanic	3		0.00577	0.0005-0.0162
			Batchman	3		0.01065	0.00016-0.0216
			Supervisor	3		0.0009	n.d.-0.0027
			Observer	6		0.0014	n.d.-0.0045
			Pilot	3	Urine	0.00854 mg/kg	n.d.-0.0237 mg/kg
			Mechanic	3		0.00301	n.d.-0.00516
			Batchman	3		0.01401	0.00053-0.0219
			Supervisor	3		0.00013	n.d.-0.00038
			Observer	6		9 x 10-5	n.d.-0.00056
Nash et al., 1982	Aerial, 585 kg a.i. applied in 20 hrs.	4 Thrush Commanders 4 Grumman Ag-Cats 4 Pipers 1 Snow 1 Cessna	Mixer-loader	6	Urine	0.0199 mg/kg	0.0008-0.0545 mg/kg
			Mixer/loader-pilot	1		0.0180	
	360 kg a.i. applied in 14 hrs.		Pilot	10		0.006 mg/kg	0.0013-0.0202 mg/kg

Table H-10 (Cont.)

Investigator	Application Type and Rate	Equipment Used	Worker Category	Number of Workers	Method of Analysis	Doses	
						Average	Range
Nash et al., 1982 (Cont.)	Ground, 34 kg a.i. applied in 3.5 hrs.	Sprayers: 4 Pull-type 21 Self-propelled 10 cab	Sprayers	9	Urine	0.012 mg/kg	n.d.-0.0760 mg/kg
	18 kg a.i. applies in 2.4 hrs.	16 no cab	Mixer-loader	7		0.0068	0.00165-0.0164
	38 kg a.i. applied in 7.9 hrs.		Mixer/ loader-sprayer	8		0.020	0.0037-0.0442
Lavy et al., 1984 (As cited in USDA, 1984)	Ground, Weedone 170 (50% 2,4-D, 50% 2,4-DP), 1 gal. herbicide/24 gal. water	Backpack	Operator	20	Urine	0.01752 mg/kg/day	n.d.-0.0903 mg/kg/day
	Tordon 101-R (80% 2,4-D, 20% Picloram)	Injection bar	Operator	20	Urine	0.0019	n.d.-0.0095
	Tordon 101-R	Hypohatchet	Operator	20	Urine	0.01696	n.d.-0.0866
	Tordon 101-R	Hack and squirt	Operator	20	Urine	0.00576	n.d.-0.0451
Note: protective coveralls, gloves, boots, hats, goggles used	Weedone 170	Backpack	Operator	20	Urine	0.0196 mg/kg/day	0.0004-0.1175 mg/kg/day
	Tordon 101-R	Injection bar	Operator	20		0.00086	n.d.-0.0035
	Tordon 101-R	Hypohatchet	Operator	20		0.0079	n.d.-0.0439
	Tordon 101-R	Hack and squirt	Operator	20		0.00244	n.d.-0.0148

precautions, the second using special protective clothing and procedures. Nash et al., 1982, monitored exposure of workers to 2,4-D during aerial spraying in Washington and ground spraying in North Dakota under normal spray conditions (i.e., without special precautions).

Lavy et al., 1984, investigated herbicide exposure to four spraying crews of 20 workers each, monitoring urine levels over two 5-day periods.

Franklin et al., 1982, estimated worker exposure in pasture brush clearing operations in Saskatchewan using techniques similar to Lavy and co-workers. Urine samples were collected from personnel who conducted operations on 3 of 4 consecutive days.

Why the Worker Dose Estimates Are Higher Than Would Occur in Actual Operations

As described above, this risk assessment estimates two separate dose levels for each category of worker in routine operations, a realistic dose and a worst case dose. The realistic dose is an estimate of the average dose a worker should receive on a typical day during normal treatment operations. The realistic dose is based on combining average nominal doses from field studies with scenario conditions that are typical for BLM operations.

However, the realistic dose estimates are higher than those that would occur in actual operations for two reasons. First, the doses are based on field study doses of applicators who wore no special protective clothing or devices. Many of the field studies measured doses to workers both with and without protective gear, and the applicators in many of BLM operations will wear protective gear, but the lower doses of protected workers were not used in extrapolating to the doses estimated in this analysis. Second, during the field exposure studies, many of the less severe types of accidents occurred that could be termed operational errors. For example, pilots handled the transfer hoses and helped with the mixing and loading operations and, in one instance when a pump broke down, transferred spray mix by bucket to the spray tank. In both of these cases, these individuals received higher doses during that day's work than they would have otherwise. Nevertheless, their doses were used in deriving the average worker doses for that field study.

The worst case estimates of worker doses in routine operations are extremely high for two reasons. First, the nominal dose levels from the field studies used for extrapolation are not the average doses seen but the dose at the upper limit of the 95-percent confidence interval. This means that there is only 1 chance in 40 that a worker in the same field operation under the same conditions of terrain, weather, and equipment should receive a dose higher than the specified dose. Second, when this upper limit dose is combined with the assumptions of largest site size and highest application rate for dose extrapolation, extremely high doses are estimated that are unlikely to occur under true operational conditions. The probability of all of these events occurring at the same time, as discussed in Section 4, is less than 1 in 10,000. No workers are likely to receive a higher dose under routine operational conditions unless they are involved in one of the accidents described later in the subsection Estimation of Doses to Workers and the Public from Accidents.

Because of the large number of actual field measurements, these extreme or routine-worst case estimates of doses to workers also take into account normal operational errors such as:

1. Errors of measurement during manufacturing and formulation.
2. Errors of measurement during field mixing.
3. Excessive swath overlap during application.

Public Exposures and Doses from Routine Operations

Public Exposure Categories and Calculations for Doses from Routine Operations

Herbicide doses to the public potentially exposed to routine herbicide applications were estimated using six application scenarios. They are the same as the worker scenarios except hack-and-squirt and injection-bar methods were not included. The hand application scenario was excluded because no drift is involved and the chance that any other type of public contact with the herbicides might occur in these operations is negligible. In the remaining six scenarios, inhalation exposure was not estimated because none of the herbicides in question is a specific lung toxicant and because the worker field studies have consistently shown inhalation exposure to be an insignificant fraction of the total herbicide dose received (USDA, 1984). Only dermal field studies have consistently shown inhalation exposure to be an insignificant fraction of the total herbicide dose received (USDA, 1984). Only dermal and dietary routes of exposure were considered in this analysis.

The scenarios used for deriving routine-realistic public exposures and doses were:

1. Helicopter spraying of a single 40-acre silviculture site.
2. Truck spraying of a 12-acre roadway right-of-way.
3. Backpack spraying of a 6-acre facility's maintenance site by two applicators for 6 hours.

The scenarios used for deriving routine-worst case public exposures and doses were:

1. Fixed-wing spraying of a 400-acre site for range improvement.
2. Truck spraying of 40 acres of transmission line right-of-way.
3. Backpack spraying of a 60-acre conifer release site by 14 applicators for 9 hours.

Single Routes of Exposure. The following categories of exposure were estimated for each scenario: doses due to drift, vegetation contact by a hiker or berrypicker, and the dietary exposures shown in Table H-8.

Dermal dose estimates were derived from the estimated dermal exposure levels by assuming that 2 square feet of a person's skin was exposed and by adjusting for the dermal penetration rate of each herbicide. Ingestion dose estimates were made for the five specific food items and drinking water that receive herbicide residues shown in Table H-8.

Multiple Routes of Exposure. In addition to estimating doses to the public from routine operations through the specific exposure routes described above, five categories of persons were assumed to receive doses simultaneously through a number of exposure routes: (1) a hiker, (2) a person who picks berries, (3) a hunter, (4) a fisherman, and (5) a nearby resident. Each of these persons was assumed to receive an herbicide dose that is the sum of the doses from several routes of exposure as shown in Table H-11.

It is extremely unlikely that a member of the public will receive simultaneous herbicide doses through more than two of the exposure routes described above. However, to ensure that no possible dose was omitted from the analysis, it was assumed that the hiker receives dermal exposure from drift as well as vegetation contact exposure from brushing against offsite plants that have received drift. The hiker also drinks water that has received herbicide drift. The berrypicker receives the same dermal and drinking water exposure from drift as the hiker, but the berrypicker is exposed to a higher level of vegetation contact exposure from brushing against plants that have received drift because of continuous contact with the berry plants. The berrypicker also receives exposure from feeding on berries that have herbicide residues from drift.

The hunter is assumed to get the same dermal exposure, vegetation contact, and drinking water exposure as the hiker. In addition, the hunter is assumed to kill and eat a deer and a game bird that have been exposed and have fed on items in the area of herbicide drift. The fisherman receives the same doses as the hunter, except the fisherman eats fish taken from a pond that has received drift rather than eating a deer and a game bird. The nearby resident receives the same dermal exposure, vegetation contact, and drinking water exposure as the hunter, but the resident eats vegetables from a garden that has received herbicide drift.

Table H-11
Multiple Routes of Exposure for Example People

Example People	Direct Dermal	Reentry Hiker	Reentry Berrypicker	Drinking Water	Eating				
					Berries	Vegetables	Deer	Bird	Fish
Hiker	X	X		X					
Berrypicker	X		X	X	X				
Hunter	X	X		X			X	X	
Fisherman	X	X		X					X
Nearby Resident	X	X		X		X			

X = Member of the public exposed by this route.

Public Dose Estimation

Because no field studies existed on actual doses to the public comparable to those used for estimating worker doses, it was necessary to estimate public doses by modeling the transport and fate of the applied herbicides. Details of the transport and fate modeling are in the next subsection.

Surface herbicide residue levels were estimated using data from field studies of the drift and surface deposition of herbicides in aerial and ground-based spray operations. These empirical studies were used to calculate how much was deposited on people's skin and how much was deposited on food and vegetation, and in bodies of water.

The exposure models required input of expected distances to various sources of human exposure. Table H-12 illustrates the distances to sources of public exposure in each scenario. The distances were derived from an examination of currently used mitigation measures.

Table H-12
Distances to Sources of Public Exposure

Treatment	Distance To: Fishing Stream	Distance To: Browsing Wildlife	Distance To: Residence
Routine-Realistic Case			
Helicopter Spraying 40-acre Silviculture Site	50'	100'	600'
Truck Spraying 4-acre Right-of-way	20'	50'	100'
Backpack Treatment of 6-acre Facility	20'	50'	100'
Routine-Worst Case			
Fixed-wing 400-acre Range Improvement	50'	100'	100'
Truck Spraying 40-acre Right-of-way	20'	50'	50'
Backpack Treatment 60-acre Conifer Release	20'	50'	50'

Example Calculation for a Routine-Realistic Right-of-Way Operation. Dose **of atrazine to human from consuming 400 grams of fish.**

The first step was to calculate the concentration per pound applied of the pesticide in a water body 6 inches deep. According to Table H-13, the value of drift to water for the scenario is 0.0264 mg/ft^2.

The concentration in a 6-inch deep body of water per pound applied per acre is:

$$\frac{.0264\ \text{mg}}{\text{ft}^2} \times \frac{1}{0.5\ \text{ft}} \times \frac{\text{ft}^3}{28.3\ \text{kg/ft}^3} \times 1000\ \frac{\text{ppb}}{\text{ppm}} = 1.86\ \text{ppb}$$

The concentration of atrazine is adjusted for the lbs/acre applied for the scenario in Table H-9:

$$1.86\ \text{ppb} \times 3.00 = 5.58\ \text{ppb}$$

The concentration in the fish is based on the bioconcentration factor of atrazine:

$$5.58\ \text{ppb} \times 5(\text{BCF}) = 27.9\ \text{ppb}$$

The dose to a 50-kg human based on consumption of 0.4 kg of fish is:

$$\frac{(27.9\ \text{ug/kg} \times 0.4\ \text{kg})}{50\ \text{kg}} = .223\ \text{ug/kg}$$

This value is given in Table B-17.

Why the Public Dose Estimates Are Higher than Would Occur from Actual Operations

The doses estimated for members of the general public are overestimates for a number of reasons. First, downwind concentrations on surfaces used to compute dermal exposure were those found on flat mylar deposition sheets.

The smaller spray particles in offsite drift tend to move around rather than impact on curved surfaces and therefore would have less of a tendency to adhere to a human's body. Second, no degradation of the herbicide is assumed to occur nor is the herbicide assumed to bind with any material, such as vegetation, so as to become biologically unavailable to humans. This would be an important factor in diminishing doses that may occur from any activity involving contact with treated vegetation.

The routine-worst case dose levels to the public can be considered the highest possible doses for routine spray operations because the doses are calculated in scenarios that combine many unlikely factors and events, including largest site size, highest application rate, least favorable weather conditions, and spray equipment most susceptible to offsite drift. No member of the public should get a dose that is any higher than the doses estimated in the routine-worst case scenarios except in the case of an accident.

Modeling Public Exposures and Doses

The following subsection presents a detailed discussion of the transport and fate modeling used in estimating herbicide doses to the public. Various sources for assumptions and methods of calculation were consulted (Dost, 1983; Crump, 1983; Simmons, 1983; USDA, 1984).

Spray Drift

The potential for herbicide sprays to drift onto adjacent lands or in nearby bodies of water was assessed based entirely on the results o empirical studies reported in the scientific literature. The analysis considered deposition on surfaces including exposed skin, water, game animals, and various classes of plants that may contribute directly or indirectly to the human diet.

Specific field studies were chosen to best represent the equipment and conditions appropriate for each scenario. Unfavorable conditions were chosen to show the degree of drift that could occur under the routine-worst case scenarios. Drift estimates for sprays applied in large range improvement projects were made based on the drift of 2,4-D from a fixed-wing aircraft (Miller, 1980). This test was conducted when winds averaged 9.5 mph. Mitigation measures specify no spraying if winds exceed 5 mph. Drift estimates for sprays applied in silvicultural projects were made based on drift of a dye tracer solution sprayed over a coniferous seed orchard by helicopter (Barry et al., 1983). The winds ranged from 4.5 to 9 mph. Drift of sprays applied by ground equipment was estimated based on a field test reported in Yates et al. (1978). In this test, glyphosate was sprayed by a ground sprayer when winds were 8.5 mph.

To facilitate use of the data from the various published field tests discussed above, a computer program was written to show how residues accumulate from multiple swaths (the long, narrow pattern of herbicide laid down by a broadcast sprayer such as an aircraft) and to correct for various application rates and swath widths. The program was then run to calculate deposition at selected representative distances for a nominal application rate of 1 pound per acre. The results are given in Table H-13 for each of the six broadcast spray scenarios. The drift calculated for water bodies is intended to represent deposition at the edge of a minimum buffer strip (50 feet for aerial spraying and 20 feet for ground spraying).

Residues on Plants

Herbicide residues on plants on treated sites were estimated based on factors reported by Hoerger and Kenaga (1972). These factors were derived from a large number of studies, and they allow prediction of residues in parts per million (ppm) based on the application rate in pounds per acre. These residue estimates were calculated assuming no herbicide degradation, so they apply to conditions immediately after application. Following Hoerger and Kenaga (1972) the plants were classified into broad groups based on vegetative yield, surface-to-mass ratio, and plant interception factors. The residues estimated for each type of plant are intended to represent realistic yet relatively high estimates.

Offsite plant residues were calculated first for grasses based on the spray drift data discussed in the previous section and by using a regression equation given in Yates et al. (1978) to relate spray deposition on young wheat plants to that on sampling devices. The deposition was then estimated for other plant groups including berries and leafy vegetables by using the same relative factors given by Hoerger and Kenaga (1972), assuming that deposition on young wheat was approximately the same as deposition on range grass.

Table H-13
Drift in mg/ft^2 Based on 1 lb/Acre
for Routine Scenarios

Aerial Scenario	Realistic	Worst Case
Aerial Scenario		
To Public and Crops	0.0020	1.0595
To Berries and Animals	0.1571	1.0595
To Water	0.6682	2.2491
Right-of-Way Scenario		
To Public and Crops	0.0043	0.0150
To Berries and Animals	0.0090	0.0150
To Water	0.0264	0.0353
Backpack Scenario		
To Public and Crops	0.0222	0.0428
To Berries and Animals	0.0341	0.0428
To Water	0.0588	0.0678

Herbicide doses to individuals were calculated assuming that they eat 400 grams (0.9 pounds) of contaminated berries or peas.

Residues in Water

Residues in water were calculated assuming that the water is only 6 inches deep, and that the herbicide spray drifts directly downwind to the water body over a minimum buffer distance. The buffer strips were assumed to be only 50 feet for aerial spraying and 20 feet for ground spraying. The actual residues in water would be less under more favorable spray conditions, at greater distances, or with deeper water bodies. For example, if the water were 2 feet deep then the residues would be only one-fourth of those calculated for this analysis. Dilution or degradation would also decrease residues. Herbicide doses to individuals were calculated assuming that they drink 1 liter of the maximally contaminated water.

Residues in Game Animals

Residues were calculated for two representative game animals: a 150-pound deer and a 0.25-pound game bird, such as a quail. The entire body surface area of the animal was assumed to be exposed to spray drift as shown in Table H-13. Forty percent of the body surface was assumed to contact vegetation and thereby gain an additional average dermal residue level equal to that on the vegetation. Penetration of the herbicides through animal skin was assumed to be the same as through human skin.

The game animals were assumed to get an oral dose both by grooming and in their diet. The dose from grooming was assumed to amount to 29 percent of the nonabsorbed dermal dose for deer, and 40 percent for quail. The deer diet was assumed to consist of 2.45 kg of forage plants and 4 liters of water per day, both containing the herbicide. The quail diet was assumed to consist of 33 g of seed (grain) per day and 15 ml of water, both containing herbicide.

The concentration of herbicide in game meat was calculated by summing the animal's doses from both the dermal and oral routes of exposure and by assuming that 10 percent of that total dose was retained in the meat of the animal. This is similar to the method used in the exposure analysis of USDA (1984). Herbicide doses to humans were calculated by assuming that they eat 400 g of deer meat or 400 g of bird meat per day.

Residues in Fish

Residues in fish were calculated assuming that the fish lived in and were caught from waters 6 inches deep, directly downwind of a treated site, with a minimum buffer strip of 20 feet for ground-based applications and 50 feet for aerial applications. For most of the herbicides considered in this analysis, which do not appreciably bioaccumulate, the concentration in fish were taken to be equal to the particular herbicide's concentrations in water. For the herbicides for which bioconcentration is likely to be greater--atrazine, diuron, and tebuthiuron--a bioconcentration factor was used. A bioconcentration factor of 10 was used for tebuthiuron, a value of 5 was used for atrazine, and a bioconcentration factor of 20 was used for diuron (Koeman et al., 1969). Doses to humans from eating fish containing herbicide were calculated assuming that 400 g are eaten daily.

Dermal Exposure

Dermal exposure due to drift was estimated by assuming that 2 square feet of skin were exposed (Dost, 1983) and the level of deposition on skin is the same as that found on the sampling sheets used in the drift monitoring studies. The dose was calculated as the deposited amount times the dermal penetration rate.

Indirect dermal exposure due to contact with foliage with surface residues of drifted herbicide was calculated by using the "unified field model" of Popendorf and Leffingwell (1982) and Popendorf (1985). This model was developed to estimate the possible doses and effects of insecticides on agricultural workers. The model was applied to estimate the relatively heavy exposures that could result from extensive foliage contact, such as that which would be experienced in berrypicking. The model takes into account:

1. The residue on foliage at any point in time after application (this analysis assumes no decay after initial application).

2. A crop-specific residue transfer coefficient (cm^2/hr).

3. The exposure period in hours.

4. The dermal penetration rate for each herbicide and the body mass of a human (50 kg).

The residue transfer coefficient has been determined for a few agricultural situations. The value of 1,600 cm^2/hour for this coefficient was used in this analysis to estimate doses to berrypickers. This value, derived from data collected for grape harvesting (Popendorf, 1985), represents a relatively high exposure situation. People engaged in activities involving less foliage contact, for example, tree planting, can be expected to receive doses that are considerably less. People who contacted foliage after the initial application also receive reduced doses due to degradation of the herbicides (see Table H-16).

Dermal doses due to incidental contact with foliage, represented in the scenarios by vegetation contact for the hiker, were estimated by another method. Lavy et al. (1980) measured the level of 2,4,5-T on cloth patch samplers attached to a person who walked through a treated forest area. The residues were less than the detection limit of 0.01 mg per 100 cm^2 patch, but in this analysis a conservative assumption was made that the residues were at the detection limit. The area of clothing contacting foliage was assumed to be 40 percent of the total human surface area, and 10 percent of the total area was assumed to be bare skin contacting foliage. The same dermal penetration rates discussed previously were applied to bare skin, but the penetration through clothing was assumed to be 30 percent over a 6-hour period, based on work by Newton and Norris (1981).

Estimation of Doses to Workers and the Public from Accidents

The following scenarios were used to estimate the worst case doses that would result from the exposure to high amounts of herbicide that could occur in accidents.

1. Accidental Spraying. Members of the public are accidentally sprayed with herbicide because they are beneath a spray aircraft or too close to a truck or backpack applicator. (This dose would also apply to workers.) Indirect exposures to the same categories of people examined in the routine scenario are also estimated here. However, in the accidental-worst case spraying scenario, all items that they eat, drink, or brush against are sprayed at the full application rate, not just through drift.

2. Spills. Members of the public receive herbicide exposure via drinking water when a load of herbicide mixture is spilled or when a container of herbicide concentrate breaks open and spills into a drinking water supply. Workers spill concentrate or prepared spray mixture on their skin during mixing, loading, or spraying operations; or are doused when a transfer hose breaks.

Accidental dermal doses were derived from modeling the dermal penetration of herbicide concentrate or mixture for direct exposures. Accidental ingestion doses were estimated by modeling the dilution of herbicide concentrate or mixture in a body of water of a given size.

To calculate the dose to a person directly sprayed at the full per-acre application rate, the worst case application rates shown in Table H-9 were converted to mg/ft^2. It is assumed that 2 square feet of human skin is exposed (Dost, 1983).

For example, the application rate of dicamba in the routine-worst case aerial application scenario is 4.0 lb a.i./acre (Table H-9). This can be converted to kg/ha by the use of a conversion factor:

$$4.0 \text{ lb. a.i./acre} \times 1.12 \frac{\text{kg/ha}}{\text{lb/acre}} = 4.48 \text{ kg. a.i./ha.}$$

$$4.48 \text{ kg. a.i./ha} \times 10^6 \frac{\text{mg}}{\text{kg}} \times 0.0001 \text{ ha/m}^2 \times 0.093 \frac{\text{m}^2}{\text{ft}^2} = 41.6 \text{ mg/ft}^2.$$

If ft^2 of skin are exposed on a 50 kg person, then the surface deposit in mg/kg would be 41.6 mg/ft^2. The absorbed dose must consider the dermal penetration rate: 1.66 mg/kg x 0.05 (dermal penetration rate) = 0.083 mg/kg absorbed. This is equivalent to 83 ug/kg, as given in Table H-21.

Reentry exposure to the general public is estimated assuming an individual walks through a treated area after an operation has been completed, even though the area is posted. Reentry exposure is also calculated for an individual who picks berries for 4 hours in a treated area, even though the area is posted. Accidental dietary exposure is derived by assuming an individual eats food items that have been directly sprayed rather than food items receiving only spray drift, or eats meat from animals that have fed directly on sprayed vegetation or fish taken from directly sprayed water bodies or drinking water from those water bodies.

An individual receives an accidental ingestion exposure resulting from a major spill by drinking water from a pond or a reservoir that has been contaminated by a dump of 100 gallons of herbicide mix as from a helicopter, or 2,000 gallons of spray mix from a batch truck. Two thousand gallons is approximately the largest amount of spray mix that might be carried by a tank truck supplying a large aerial spraying operation. One hundred gallons is approximately the largest load that can be carried by the types of helicopters currently used in the Pacific Northwest. The maximum herbicide concentrations in drums and batch trucks are shown in Table H-14. The pond is assumed to be 1 acre in area and 4 feet deep, and to have no inflow or outflow. The reservoir is assumed to be 16 acres in area and 8 feet deep. A person is assumed to drink 1 liter of water after complete mixing has occurred.

Direct dermal exposures were calculated for spills of 0.5 liter of herbicide concentrate (if liquid concentrates are used) or 0.5 liter of the most concentrated spray mixture. The person exposed during the spill is assumed to weigh 50 kg, and most of his surface area (0.8 m^2 or 8.6 ft^2) is thoroughly wetted by the solution. Denim fabric commonly used in clothing retains about 57.5 ml of solution per square foot (Weeks, 1985), and absorption of herbicide through the cloth was calculated as before, based on Newton and Norris (1981). However, 20 percent of the solution was assumed to wet bare skin. A spill resulting in this exposure could result from broken hoses, spilled containers, or emergency and accidental dumps by helicopters.

Table H-14
Maximum Herbicide Concentrations in Drums and Batch Trucks

Herbicide	Pounds per Gallon Concentrate	Pounds per 50-Gallon Drum	Pounds per 2,000-Gallon Batch Tank
Amitrole	2.	100	800
Asulam	4.	200	668
Atrazine	4.	200	800
Bromacil	4.	200	400
2,4-D	4.	200	800
2,4-DP	6.	300	500
Dalapon	--[a]	--	2,000
Dicamba	4.	200	800
Diuron	4.	200	640
Fosamine	4.	200	2,400
Glyphosate	3.	150	1000
Hexazinone	2.	100	600
Picloram	2.	100	1000
Simazine	4.	200	1000
Tebuthiuron	--	--	1200
Triclopyr	4.	200	1600

[a] Not purchased in liquid formulation by the Forest Service or BLM.

Estimation of Lifetime Doses to Workers and the Public

Doses used in the cancer risk analysis for 2,4-D, 2,4-DP, picloram, amitrole, asulam, bromacil, and glyphosate (discussed in Section 4) were derived by combining available information on the number of days per year an individual worker may spray an herbicide using a particular application method, and estimates of the expected daily dose and the number of years of employment. Expected daily doses were calculated assuming that the worst-case dose is experienced 5 percent of the time and the realistic dose 95 percent of the time, in all routine scenarios. The realistic cases assume that workers are employed in pesticide application for 5 years, and the worst cases assume 20 years employment in herbicide applications.

Average numbers of exposures per lifetime were used with expected daily doses for each scenario to derive realistic lifetime doses. Extreme lifetime doses were derived by multiplying expected daily dose levels estimated in worker scenarios by estimates of the highest number of days a worker is likely to be engaged in the particular type of application method. Exposures per lifetime in the realistic scenarios were estimated to be the following: aerial, 30; right-of-way, 45; backpack, 50; and hand application, 70. For the routine-worst case scenario doses, the number of exposures per lifetime were: aerial, 288; right-of-way, 416; backpack, 440; and hand application, 480.

Lifetime exposures to the public for the five herbicides were derived by assuming a realistic estimate would be a single exposure per lifetime in each of the public exposure scenarios, and a high estimate would be one exposure per year for 30 years. The exposure levels derived in the realistic and extreme public scenarios and on accidental spraying and spills were multiplied by 1 for realistic lifetime and 30 for extreme lifetime doses.

Effect of Body Size on Exposure

All doses estimated in the exposure analysis were calculated for a representative 50-kg person. This weight was chosen to represent an adult of less than average weight, so that doses to adults would be calculated in a conservative manner. Doses for a larger person would be less in terms of mg per kg body weight. For example, a 70-kg person would receive approximately 25 percent more herbicide than a 50-kg person by dermal exposure, because of his greater surface area. A 70-kg person would also receive on average about 25 percent more herbicide by dietary exposure routes, because both body surface area and metabolism are approximately proportional to body weight raised to the 2/3 power:

$$\frac{(70)^{2/3}}{(50)^{2/3}} = 1.25$$

However, a 70-kg person also has a body weight greater than a 50-kg person, by a greater factor:

$$\frac{70}{50} = 1.4$$

The combined effect of these two factors is that a 70-kg person will receive a dose in mg/kg that is only 89 percent as great as for a 50-kg person.

Conversely, smaller people can be expected to receive greater doses in terms of mg per kg body weight. A 20-kg child will receive only about 54 percent as much herbicide as a 50-kg person, but his weight is only 40 percent as great. The net effect is that a 20-kg child will receive a dose that is 36 percent greater in terms of mg/kg than it would be for a 50-kg person.

Table H-15 illustrates the effect of body size on expected dose. The table shows doses for a 20-kg child and 50- and 70-kg adults for each route of exposure in the extreme aerial application scenario.

Time Dependence of Dermal Exposure Due to Vegetation Contact

Herbicide residues on plant surfaces decline over time as a result of absorption by the plant, degradation, volatilization, and washing by rainfall. After herbicide sprays dry on plant surfaces they cannot be completely rubbed off because of binding to the plant surface materials. Consequently, persons entering a treated area a short time after spraying are likely to receive dermal doses much smaller than the conservative doses calculated in this analysis. However, specific data were not available

Table H-15
Effect of Body Size on Dose:
2,4-D Aerial Routine-Worst Case Scenario
(doses in micrograms/kg)

Exposure Route	20-kg Child	50-kg Adult	70-kg Adult
Drift, Dermal	13.86	10.19	9.07
Veg. Contact, Hiker	0.20	0.15	0.13
Veg. Contact, Picker	35.72	26.27	23.38
Drinking Water	17.25	12.68	11.29
Eating Berries	14.18	10.42	9.28
Eating Vegetables	28.35	20.85	18.55
Eating Deer Meat	2.16	1.59	1.41
Eating Game Bird	9.20	6.77	6.02
Eating Fish	6.90	5.07	4.51

for most of the 16 herbicides regarding persistence on plant surfaces. The most appropriate data would be measurements of dislodgeable residues, but this type of data was not available for the herbicides. In most cases, measurements of total plant residues over time were available, so these data have been used to calculate degradation rates in those cases where surface measurements were unavailable. Degradation rates calculated in this way should be considered minimum degradation rates for dislodgeable residues, because the residues that were measured in deriving the data may have been largely or entirely unavailable for dermal exposure through vegetation contact.

Table H-16 shows the dermal exposures calculated for a hiker and a person picking berries for 4 hours on a treated site. The table shows the doses at the first day and also after 30 and 90 days. The doses decline dramatically even with these minimum rates of degradation. In the case of bromacil, no degradation rate was found in the available literature, so a minimal degradation rate corresponding to a half life of 60 days was used. The actual rate of degradation is likely to be greater.

Even the 90-day time period is considerably less than the minimum period between treatment for site preparation and reentry for tree planting. Vegetation contact for tree planters is also much less than for berry-pickers, so the maximum dose for planters will be significantly less.

Table H-16
Doses Due to Vegetation Contact on a Treated Site
(micrograms/kg)

Herbicide	Degradation Rate per Day	Hiker Day 1	Hiker Day 30	Hiker Day 90	Berrypicker Day 1	Berrypicker Day 30	Berrypicker Day 90
Amitrole	0.0866	12.0	0.9	0.0	7168.0	533.5	3.0
Asulam	0.0110	4.2	3.0	1.6	2508.8	1803.6	932.2
Atrazine	0.0621	15.0	2.3	0.1	8960.0	1390.6	33.5
Bromacil	0.0116	18.0	12.7	6.3	10752.0	7592.0	3785.2
2,4-D	0.0431	2.0	0.6	0.0	1225.7	336.4	25.3
2,4-DP	0.0431	3.0	0.8	0.1	1792.0	491.8	37.0
Dalapon	0.0542	18.0	3.5	0.1	10752.0	2115.1	81.8
Dicamba	0.0578	4.8	0.8	0.0	2867.2	506.3	15.8
Diuron	0.2740	35.9	0.0	0.0	21504.0	5.8	0.0
Fosamine	0.0990	7.2	0.4	0.0	4300.8	220.5	0.6
Glyphosate	0.0495	3.0	0.7	0.0	1792.0	405.9	20.8
Hexazinone	0.0584	7.2	1.2	0.0	4300.8	745.9	22.4
Picloram	0.0693	0.0	0.0	0.0	18.6	2.3	0.0
Simazine	0.0455	2.8	0.7	0.0	1648.6	421.0	27.5
Tebuthiuron	0.0834	4.8	0.4	0.0	2867.2	234.9	1.6
Triclopyr	0.3120	4.8	0.0	0.0	2867.2	0.2	0.0

EXPOSURE ANALYSIS RESULTS

This subsection presents the results of the exposure analysis. Doses to workers and the public estimated for routine operations and for accidents are summarized and discussed. Complete dose estimates are presented in Attachment B.

Doses to Workers

Realistic Worker Doses in Routine Operations

Routine-realistic worker doses are summarized in Table H-17. No worker in any of the realistic scenarios receives a dose of any herbicide greater than 1.0 mg/kg. All backpack workers receive doses greater than 0.1 mg/kg except those using amitrole, dicamba, and picloram. Helicopter mixer-loaders receive atrazine doses greater than 0.1 mg/kg, but all other doses in the realistic aerial scenario for mixer-loaders, pilots, supervisors, and observers are less than 0.1 mg/kg. Bromacil, 2,4-DP, diuron, fosamine, and triclopyr doses to hack-and-squirt applicators are greater than 0.1 mg/kg. All other hand application doses are less than 0.1 mg/kg.

Worst Case Worker Doses in Routine Operations

In the routine-worst case worker application scenarios (summarized in Table H-18), doses to aerial supervisors and observers, right-of-way applicators, and injection-bar applicators are all less than 1.0 mg/kg. Doses of triclopyr exceed 1.0 mg/kg for pilots and mixer-loaders in the aerial scenario. All herbicide doses to backpack workers exceed 1.0 mg/kg except for amitrole and picloram. Hack-and-squirt applicator doses of bromacil, 2,4-DP, diuron, fosamine, and triclopyr all exceed 1.0 mg/kg. All other doses are less than 1.0 mg/kg.

Doses to the Public

Doses via Individual Exposure Routes

Doses to the public via specific exposure routes in the three routine-realistic scenarios are shown in Attachment B. In none of the routine-realistic scenarios does the public receive a dose greater than 0.01 mg/kg (10 micrograms/kg) for any of the 16 herbicides through any single exposure route. Doses are lowest (less than 0.006 micrograms/kg) to the hiker who contacts vegetation with herbicide residues. Doses are highest for the ingestion routes of exposure, particularly drinking water and eating berries or garden vegetables.

Doses to the public via individual exposure routes in the routine-worst case scenarios also are shown in Attachment B. No dose to the public is greater than 0.01 mg/kg for any chemical through any exposure route in either the truck (right-of-way) or backpack scenarios. Highest public doses occur in the routine-worst case aerial scenario. However, doses are less than 0.1 mg/kg for all the herbicides.

Table H-17
Worker Doses for Routine-Realistic Scenarios

Herbicide	Aerial					Truck			Hand Application	
	Pilot	Mix/L	Sup	Obs	Backpack	Appl	Mix/L	App M/L	Hack/ Squirt	Inj Bar
Amitrole	--	--	--	--	1	-1	-1	-1	0	0
Asulam	--	--	--	--	3	1	1	2	--	--
Atrazine	2	3	2	1	3	2	2	2	--	--
Bromacil	--	--	--	--	3	2	2	2	3	2
2,4-D	2	2	1	0	3	1	1	1	2	2
2,4-DP	--	--	--	--	3	1	1	1	3	2
Dalapon	--	--	--	--	3	2	2	2	--	--
Dicamba	--	--	--	--	2	1	1	1	2	2
Diuron	--	--	--	--	3	2	2	2	3	2
Fosamine	--	--	--	--	3	2	2	2	3	2
Glyphosate	--	--	--	--	3	1	1	1	--	--
Hexazinone	2	2	1	1	3	1	1	2	--	--
Picloram	0	1	0	-1	1	0	0	0	1	1
Simazine	--	--	--	--	3	1	1	1	--	--
Tebuthiuron	--	--	--	--	3	1	1	2	--	--
Triclopyr	2	2	1	1	3	1	1	1	3	2

Legend

4	10.0 mg/kg
3	1.0 mg/kg (less than 1 milligram/kg)
2	0.1 mg/kg
1	0.01 mg/kg
0	0.001 mg/kg (less than 1 microgram/kg)
-1	0.0001 mg/kg
-2	0.00001 mg/kg

-- herbicide not used in this scenario

Table H-18
Worker Doses for Routine-Worst Case Scenarios

Herbicide	Aerial					Truck			Hand Application	
	Pilot	Mix/L	Sup	Obs	Backpack	Appl	Mix/L	App M/L	Hack/ Squirt	Inj Bar
Amitrole	--	--	--	--	2	1	1	1	2	1
Asulam	--	--	--	--	4	3	3	3	--	--
Atrazine	3	3	3	2	4	3	3	3	--	--
Bromacil	--	--	--	--	4	3	3	3	4	3
2,4-D	3	3	2	2	4	3	2	2	4	3
2,4-DP	--	--	--	--	4	3	2	3	4	3
Dalapon	--	--	--	--	4	3	3	3	--	--
Dicamba	--	--	--	--	4	2	2	2	3	
Diuron	--	--	--	--	4	3	3	3	4	3
Fosamine	--	--	--	--	4	3	3	3	4	3
Glyphosate	--	--	--	--	4	3	3	3	--	--
Hexazinone	3	3	2	2	4	3	3	3	--	--
Picloram	2	2	1	1	3	1	1	1	2	1
Simazine	--	--	--	--	4	3	3	3	--	--
Tebuthiuron	--	--	--	--	4	3	3	3	--	--
Triclopyr	4	4	3	2	4	3	3	3	4	3

Dose Levels

4	10.0 mg/kg
3	1.0 mg/kg
2	0.1 mg/kg
1	0.01 mg/kg
0	0.001 mg/kg
-1	0.0001 mg/kg
-2	0.00001 mg/kg

-- herbicide not used in this scenario

Doses Via Multiple Exposure Routes

Doses for people who receive combined herbicide doses of each of the 16 herbicides through the various exposure routes outlined in Table H-11 are listed for the three routine-realistic scenarios in Table H-19, and for the three routine-worst case scenarios in Table H-20.

In no instance do any of the combined doses of any of the herbicides in the routine-realistic scenarios exceed 0.1 mg/kg. Those that exceed 0.01 mg/kg (berrypickers for atrazine, dalapon, and simazine; fishermen for atrazine) are all lower than 0.015 mg/kg (see Attachment B).

No representative member of the public receives a dose of any herbicide higher than 0.01 mg/kg in the routine-worst case right-of-way scenario. Dalapon and fosamine doses to berrypickers exceed 0.01 mg/kg in the routine-worst case backpack scenario. Highest public doses range from greater than 0.01 mg/kg to less than 0.3 mg/kg for combined public doses in the routine-worst case aerial scenario for all 16 herbicides.

Accidental Doses to Workers and the Public

Doses from Accidental Spraying

Doses to workers and members of the public from accidental spraying are listed for the 16 herbicides in Table H-21. The table lists doses in micrograms/kg rather than mg/kg (1 mg = 1,000 micrograms). Doses exceed 1 mg/kg for berrypicker dermal exposure (reentry) for bromacil, dalapon, diuron, and fosamine. Doses of diuron from eating fish exceed 1 mg/kg. All other doses are less than 1 mg/kg.

Doses to representative members of the public from accidental spraying, listed in Table H-22, exceed 1 mg/kg for the berrypicker for atrazine, bromacil, dalapon, hexazinone, tebuthiuron, and triclopyr. Doses of fosamine to the berrypicker exceed 2 mg/kg. Doses of diuron to the hunter and nearby resident exceed 1 mg/kg; for the berrypicker and fisherman, doses exceed 2 mg/kg. All doses of all other herbicides are less than 1 mg/kg for representative members of the public in spraying accidents.

Doses from Spills

Doses from spill accidents, both direct dermal and via drinking water, are listed in Table H-23. The spill doses are listed in mg/kg (not micrograms/kg as in the spraying accidents). By far, the highest doses are received in worker spill accidents where workers receive doses exceeding 100 mg/kg for all the herbicides except amitrole, dalapon, picloram, and tebuthiuron. Spills of mixture on workers' skin lead to estimated doses that exceed 10 mg/kg for all herbicides except amitrole, 2,4-DP, and picloram. Doses to the public from truck spills rarely exceed 1 mg/kg. Those from helicopter dumps into a reservoir never exceed 0.01 mg/kg.

Lifetime Doses

Lifetime doses to workers and the public from herbicide spraying for a specified number of exposures over a 70-year lifetime are listed in the final set of tables in Attachment B. Cancer risk based on the specified number of exposures is discussed in Section 4.

Table H-19
Doses to Example People in Routine-Realistic Exposure Scenarios

	Aerial					Truck (row)					Backpack				
	Hiker	Berry-picker	Hunter	Fisher-man	Nearby Resident	Hiker	Berry-picker	Hunter	Fisher-man	Nearby Resident	Hiker	Berry picker	Hunter	Fisher-man	Nearby Resident
Amitrole	1	1	1	1	1	-1	0	0	0	0	0	0	0	0	0
Asulam	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Atrazine	1	2	1	2	1	0	0	0	0	0	0	1	0	1	1
Bromacil	--	--	--	--	--	1	1	1	1	1	1	1	1	1	1
2,4-D	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0
2,4-DP	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0
Dalapon	1	2	1	1	1	0	0	0	0	0	0	1	1	0	1
Dicamba	0	1	1	1	1	-1	0	-1	-1	0	-1	0	0	-1	0
Diuron	--	--	--	--	--	0	0	0	1	0	0	1	1	1	1
Fosamine	1	1	1	1	1	0	0	0	0	0	0	1	0	0	1
Glyphosate	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0
Hexazinone	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Picloram	0	1	1	1	1	-1	-1	-1	-1	0	-1	0	0	0	0
Simazine	1	2	1	1	1	0	0	0	0	0	0	1	0	0	0
Tebuthiuron	0	1	1	1	1	0	0	0	0	0	0	1	0	0	0
Triclopyr	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0

Dose Levels

--	not used
2	0.1 mg/kg
1	0.01 mg/kg
0	0.001 mg/kg
-1	0.0001 mg/kg

Table H-20
Doses to Representative Members of the Public in Routine-Worst Case Exposure Scenarios

	Aerial					Truck (row)					Backpack				
	Hiker	Berry-picker	Hunter	Fisher-man	Nearby Resident	Hiker	Berry-picker	Hunter	Fisher-man	Nearby Resident	Hiker	Berry picker	Hunter	Fisher-man	Nearby Resident
Amitrole	--	--	--	--	--	0	1	0	0	1	0	1	0	0	1
Asulam	--	--	--	--	--	0	1	0	0	1	0	1	1	1	1
Atrazine	2	2	2	2	2	0	1	1	1	1	1	1	1	1	1
Bromacil	--	--	--	--	--	0	0	0	0	0	0	1	1	0	1
2,4-D	2	2	2	2	2	0	1	0	0	0	0	1	1	0	1
2,4-DP	2	2	2	2	2	0	1	0	0	1	0	1	1	1	1
Dalapon	--	--	--	--	--	1	1	1	1	1	1	2	1	1	1
Dicamba	--	--	--	--	--	0	0	0	0	0	0	1	1	0	1
Diuron	--	--	--	--	--	1	1	1	1	1	1	1	1	1	1
Fosamine	--	--	--	--	--	1	1	1	1	1	1	2	1	1	1
Glyphosate	--	--	--	--	--	0	1	0	0	1	1	1	1	1	1
Hexazinone	2	2	2	2	2	0	1	0	0	1	0	1	1	0	1
Picloram	2	2	2	2	2	0	0	0	0	0	0	1	0	0	1
Simazine	--	--	--	--	--	0	1	0	0	1	1	1	1	1	1
Tebuthiuron	--	--	--	--	--	0	1	0	1	1	1	1	1	1	1
Triclopyr	2	3	2	2	3	0	1	1	1	1	1	1	1	1	1

Dose Levels

3	1.0 mg/kg
2	0.1 mg/kg
1	0.01 mg/kg
0	0.001 mg/kg
-1	0.0001 mg/kg

Table H-21
Doses to the Public from Items Receiving the Full per-Acre Application Rate by Exposure Type, Accidental-Worst Case
(micrograms/kg)

Herbicide	Direct Dermal	Reentry Hiker	Reentry Picker	Drink Water	Eating Berries	Eating Vegs.	Eating Deer	Eating Bird	Eating Fish
Amitrole	3	0	9	117	93	194	19	116	47
Asulam	209	3	538	73	58	121	13	83	29
Atrazine	355	5	914	125	99	206	22	141	249
Bromacil	417	6	1,075	147	116	242	26	165	59
2,4-D	103	1	264	60	48	99	10	64	24
2,4-DP	133	2	344	73	58	121	13	79	29
Dalapon	417	6	1,075	147	116	242	26	165	59
Dicamba	83	1	215	59	47	97	10	62	23
Diuron	667	10	1,720	235	186	387	42	265	1,878
Fosamine	501	7	1,290	176	140	290	31	199	70
Glyphosate	209	3	538	73	58	121	13	83	29
Hexazinone	250	4	645	88	70	145	16	99	35
Picloram	10	0	26	73	58	121	12	73	29
Simazine	209	3	538	73	58	121	13	83	29
Tebuthiuron	250	4	645	88	70	145	16	99	352
Triclopyr	334	5	860	117	93	194	21	132	47

Table H-22
Doses for Example People[a] for Accidental-Worst Case Spraying
(micrograms/kg)

Herbicide	Hiker	Berry-picker	Hunter	Fisherman	Nearby Resident
Amitrole	121	222	256	168	314
Asulam	285	878	381	314	406
Atrazine	484	1,492	647	734	690
Bromacil	570	1,755	761	628	812
2,4-D	164	475	239	188	263
2,4-DP	209	609	300	238	330
Dalapon	570	1,755	761	628	812
Dicamba	143	404	215	167	240
Diuron	912	2,809	1,218	2,790	1,299
Fosamine	684	2,107	914	754	974
Glyphosate	285	878	381	314	406
Hexazinone	342	1,053	457	377	487
Picloram	84	167	168	113	204
Simazine	285	878	381	314	406
Tebuthiuron	342	1,053	457	694	487
Triclopyr	456	1,404	609	503	649

[a] All of these people receive multiple exposures as shown in Table H-11.

Table H-23
Doses from Herbicide Spills
(mg/kg)

Herbicide	Spill of One Pint Concentrate on Skin	Spill of One Pint Tank Mix on Skin	Helicopter[a] Dump into Pond	Helicopter[a] Dump into Reservoir	Truck[a] Spill into Pond	Truck[a] Spill into Reservoir
Amitrole	1.20	0.24	--	--	0.7365	0.0230
Asulam	240.00	20.04	--	--	0.6150	0.0192
Atrazine	240.00	24.00	0.0737	0.0023	0.7365	0.0230
Bromacil	240.00	12.00	--	--	0.3683	0.0115
2,4-D	144.00	14.40	0.0737	0.0023	0.7365	0.0230
2,4-DP	230.40	9.60	--	--	0.4603	0.0144
Dalapon	--	60.00	--	--	1.8413	0.0575
Dicamba	120.00	12.00	--	--	0.7365	0.0230
Diuron	240.00	19.20	--	--	0.5892	0.0184
Fosamine	240.00	72.00	--	--	2.2095	0.0690
Glyphosate	180.00	30.00	--	--	0.9206	0.0288
Hexazinone	120.00	18.00	0.0552	0.0017	0.5524	0.0173
Picloram	5.76	1.44	0.0921	0.0029	0.9206	0.0288
Simazine	240.00	30.00	--	--	0.9206	0.0288
Tebuthiuron	--	36.00	--	--	1.1048	0.0345
Triclopyr	240.00	48.00	0.1473	0.0046	1.4730	0.0460

[a] Assuming 1 liter of water drunk per day.
-- Herbicide not used in a form that could cause this kind of spill.

Section 4

HUMAN HEALTH RISK ANALYSIS

This section presents information on potential risks to the health of workers and members of the public from the proposed herbicide applications by comparing the exposure levels estimated in Section 3 with the toxic effect levels described in Section 2. The first subsection describes the methods used to evaluate risks. The second subsection evaluates the risks of threshold effects that include acute toxic effects, chronic systemic effects, and reproductive (fetotoxic and maternal toxic) and teratogenic effects. The last subsection evaluates the risks of the herbicides causing cancer or mutagenic effects in the population at risk. All judgments about risk are discussed in light of the probabilities of the estimated exposures actually occurring.

HOW THE RISKS TO WORKERS AND THE PUBLIC WERE DETERMINED

In this risk analysis, the risks to humans exposed to the 16 herbicides were quantified by comparing the doses estimated in the range of exposure scenarios presented in Section 3 with the results of toxicity tests on laboratory animals described in Section 2. There are two basic approaches for extrapolating from laboratory animal NOELs to the general human population: the acceptable daily intake approach and the margin-of-safety approach. Under the acceptable daily intake (ADI) approach, "safety factors" based on the quality of the data are applied to either the highest (Thomas, 1986; Klaassen and Doull, 1980) or lowest (EPA) NOEL dose found in animal studies. These factors have been used for the estimation of acceptable human exposures based on experimental human and animal studies where noncarcinogenic effects were observed following exposure to a toxic chemical substance (Thomas, 1986). An uncertainty factor of 10 has normally been used in the estimation of safe levels in humans from experimental studies when there are valid human studies available and no indication of carcinogenicity. An uncertainty factor of 100 is used when there are few or no human studies available but there are valid long-term animal studies; when there are very limited toxicological data 1,000 or greater could be used to estimate acceptable human exposure.

Safety factors and the "ADI approach" are used by Federal regulatory agencies such as the FDA and EPA to set ADIs for chemicals that a broad segment of the general public are liable to be exposed to for an indeterminate period of time. Thus, the ADI is a lifetime safe dose for threshold toxic effects based on the best available toxicity information on a particular chemical. Cancer and mutation effects are not dealt with in this way since they are not assumed to have a predictable threshold of reversible toxic effects.

The margin-of-safety (MOS) approach used in this risk assessment is based on the same concepts of a threshold of toxicity (approximated by animal no-observed-effect levels (NOELs) in long-term studies) and of the safety of a dose. However, it differs from the ADI approach in several important ways. First, the MOS approach is not being used here to establish a regulatory standard safe level for the general public against which samples of possibly contaminated products, for example, marketed vegetables or drinking water, would be tested. The margins-of-safety computed here are dose ratios that are direct comparisons of the doses estimated in this risk assessment with the NOELs from animal studies. For example, a MOS of 100 means the laboratory-determined level is 100 times higher than the estimated dose. Although they correspond with the safety factors used to determine the ADIs, they are applicable only to this risk assessment. It should also be pointed out that a margin-of-safety does not always mean that the dose is safe. A MOS of 3, for example, could represent a high risk of toxic effects for repeated exposures.

Second, the ADI as a standard level for comparison of tested samples should remain relatively stable over the years, modified only when the results of new toxicity tests produce a new NOEL or make a change in the ADI safety factor appropriate. The margins-of-safety in this risk assessment, however, vary with the estimated doses in a particular exposure scenario and are thus used to indicate the potential toxic effects of a proposed chemical under differing conditions or routes of exposure or in comparison with alternative chemicals that may be used for the same purpose.

For doses that are not likely to occur more than once, such as those received by workers spilling a quart of spray mix over their entire upper body, a dose estimate that exceeds the laboratory test animal NOEL does not necessarily lead to the conclusion that there will be toxic effects. All of the NOELs used in this risk analysis are based on (or take into account) long-term exposure. Estimated doses that exceed the NOEL are compared to the herbicide's acute oral LD_{50}, so that a judgment can be made on the risk of fatal effects. For convenience in this analysis, the ratio between the herbicide's LD_{50} and the estimated human dose also is expressed as a MOS; however, it should not be interpreted in the same way as the MOS based on a NOEL in terms of the expectation of no effects in humans.

The larger the margin of safety (the smaller the estimated human dose compared to the animal NOEL), the lower the risk to human health. As the estimated dose to humans approaches the animal NOEL (as the MOS approaches one), the risk to humans increases. When an estimated dose exceeds a NOEL (giving a MOS of less than one), the ratio is reversed (the dose is divided by the NOEL) to indicate how high the estimated dose is above the laboratory toxicity level; a minus sign is attached to indicate that the dose exceeded the NOEL; and the result is no longer termed a margin of safety but is called simply a negative ratio.

A ratio of -3, for example, means that the estimated dose is 3 times the laboratory-determined level. A negative ratio infers that the estimated dose (given all the assumptions of the scenario) represents a clear risk of possible acute effects if the ratio is based on the LD_{50} or of possible chronic effects if the ratio is based on the systemic or reproductive NOEL.

In general when repeated doses to humans approach the animal NOEL (the MOS is less than 10), there is some possibility of harmful effects. In general, when the MOS is less than 100, sensitive individuals may be at risk. Conversely, when the human dose is small compared with the animal NOEL (giving a MOS greater than 100), the risk to humans can be judged negligible. Comparing one-time or once-a-year doses (such as those experienced by the public) to NOELs derived from lifetime studies tends to greatly overestimate the risk from those rare events.

Systemic effects are evaluated based on the lowest systemic NOEL found in a 2-year feeding study of dogs, rats, or mice. (When subchronic studies reported effects at lower levels than chronic studies, the subchronic NOELs were used.) Reproductive effects are evaluated based on the lowest maternal, fetotoxic, or teratogenic NOEL found in a three-generation reproductive study or in a teratology study.

A worst-case analysis of cancer risk is conducted for the herbicides for which there are positive cancer studies, amitrole, asulam, atrazine, bromacil, picloram, 2,4-D, and 2,4-DP, and for herbicides for which there is scientific controversy about their ability to cause cancer, such as glyphosate. The risk of cancer is calculated for an individual by comparing estimates of lifetime dose over a 70-year period (computed in Section 3) with cancer potency estimates derived in the Hazard Analysis section. A worst-case analysis is also conducted for those herbicides that have positive mutagenicity tests or those for which no data are available. The risk of these herbicides causing mutations is qualitative rather than quantitative, with a statement of the probable risk based on the available evidence of mutagenicity and carcinogenicity.

RISK OF GENERAL SYSTEMIC AND REPRODUCTIVE EFFECTS

For each application scenario, routine-realistic, routine-worst case, and accidental-worst case assumptions were used to compute margins of safety for workers and the public for all 16 herbicides. Complete tables for each herbicide are given in Attachment C. The margins of safety were computed by comparing the laboratory-determined NOELs and LD_{50}s in Table H-24 with the doses shown in Attachment B.

Risk to the Public Under Routine Operations

Table H-25 summarizes the margin-of-safety results for the public for the 16 herbicides under both the routine-realistic and routine-worst case exposure scenarios.

Risk to the Public Under Routine-Realistic Scenarios

Margins of Safety for the Public Under Routine-Realistic Scenarios. Table H-25 shows that there are large margins of safety (greater than 150) for every category of exposure--even cumulative exposures--under the routine-realistic scenario for asulam, atrazine, bromacil, 2,4-D, 2,4-DP, dalapon, dicamba, diuron, fosamine, glyphosate, hexazinone, picloram, simazine, tebuthiuron, and triclopyr. Although the public should not be chronically exposed to these herbicides (indeed, given the remote location of most

Table H-24
Toxicity and Cancer Potency of Herbicides

Herbicide	Rat LD_{50} mg/kg	Systemic NOEL mg/kg/day	Reproductive/ Terat. NOEL mg/kg/day	Cancer Potency per mg/kg/day
Amitrole	4,080.00	0.025	5.0	1.4
Asulam	4,000.00	50.0	50.0	0.02
Atrazine	1,869.00	3.7	100.0	0.03
Bromacil	3,998.00	6.25	7.92	0.0038
2,4-D	375.00	1.0	5.0	0.0050
2,4-DP	532.00	5.0	6.25	0.059
Dalapon	7,577.00	15.0	300.0	*
Dicamba	757.00	25.0	2.5	*
Diuron	3,750.00	0.625	6.25	*
Fosamine	24,400.00	25.0	500.0	*
Glyphosate	4,320.00	31.0	10.0	0.000024
Hexazinone	1,690.00	10.0	125.0	*
Picloram	8,200.00	7.0	50.0	0.00057
Simazine	5,000.00	5.0	5.0	*
Tebuthiuron	644.00	12.5	90.0	*
Triclopyr	630.00	2.5	10.0	*

* No oncogenic potential was indicated from laboratory studies, therefore a cancer potency analysis was not conducted.

spray areas, it is unlikely that any member of the public will be exposed at all), these large margins of safety mean that they could be repeatedly exposed to these levels, or cumulatively exposed to these levels, and suffer no adverse effects. This is true for all individuals including pregnant women and the vast majority of sensitive individuals.

The greatest risk by exposure route occurs in contacting vegetation that has just been sprayed with one of the herbicides while picking berries and in eating vegetables that have received spray drift. Because of this, the representative members of the public at greatest risk from any of the herbicides are the nearby resident and the berrypicker. Exposure routes

Table H-25

Lowest Margins of Safety for the General Public Under the Routine Scenarios

Herbicide	Routine-Realistic Scenarios	Routine-Worst Case[a] Scenarios
Amitrole	All right-of-way and most backpack MOSs are greater than 50, except eating vegetables (41), and residents (32).	Many of the right-of-way and 2 of the backpack MOSs are less than 50.
Asulam	All situations 8,000 or greater.	All situations greater than 860.
Atrazine	All situations greater than 310.	All situations greater than 50 except for berrypickers (44), for the 400-acre aerial application.
Bromacil	All situations are greater than 2,200.	All situations are 700 or greater.
2,4-D	All situations greater than 150.	All right-of-way and backpack MOSs are greater than 380. All aerial MOSs are greater than 10 with the following situations having MOSs of 10 to 50: vegetation contact by picker (38), eating vegetables (48), hiker (43), berrypicker (17), hunter (32), fisherman (36) and resident (23).
2,4-DP	All situations 990 or greater.	All situations greater than 120.
Dalapon	Greater than 1,100 in all situations.	All situations greater than 100 except berrypicker (72).
Dicamba	Greater than 1000 in all situations.	All situations greater than 100.
Diuron	Greater than 180 in all situations.	All MOSs 77 or greater in all situations.
Fosamine	All greater than 2,600.	All 99 or greater.
Glyphosate	All greater than 1,500.	All 95 or greater.
Hexazinone	All greater than 1,200.	All greater than 150.
Picloram	All greater than 3,400.	All greater than 150.
Simazine	All greater than 390.	All greater than 50.
Tebuthiuron	All greater than 2,500.	All MOSs 99 or greater.
Triclopyr	All greater than 390.	All situations greater than 50 except for vegetation contact by berrypicker (29), and the multiple routes for hiker (42), berrypicker (15), hunter (32), fisherman (36), and resident (25) in the 400-acre aerial application.

[a] A margin of safety of 50 was chosen as the cutoff to report values in this table for ease of comparison. It was not intended to indicate what would be considered low or high risk.

leading to least risk are direct dermal exposure to spray drift, drinking water with drift residues, and eating animals or fish that have drift residues. Persons at least risk are the hunter, hiker, and fisherman. These relationships hold for all 16 herbicides.

MOSs for all herbicides estimated in the three routine-realistic public exposure scenarios are given in Attachment C. MOSs for the three most heavily used herbicides, 2,4-D, picloram, and triclopyr begin in Tables C-51, C-87, and C-101, respectively.

Probability of Estimated Routine-Realistic Public Doses Occurring. Although these three scenarios represent what can happen under routine operations, the probability of people receiving doses as high as those projected here is quite low.

There are no residents, hikers, fishermen, or berrypickers in the vicinity of the vast majority of treatment units. Additional precautions, such as posting the area, are normally used to ensure that no one would be exposed during or immediately after a herbicide application operation.

Moreover, as described in Section 3, these routine-realistic scenarios use a number of conservative assumptions that tend to overestimate rather than underestimate what is expected in the majority of operations. For example, predicted levels in water (which determine doses for drinking water, eating fish, and all of the cumulative exposures) are 100 times higher than levels seen in extensive field testing. Extensive monitoring studies conducted by the Forest Service for phenoxy herbicides from 1974 to 1978 showed negligible levels of herbicides in streams (all were less than 0.04 parts per million). These extremely low levels were found despite the fact that during the 1974-78 period not all herbicide applications were monitored. Only those applications most likely to result in significant residues or cause for public concern were actually monitored (USDA, 1980).

The levels predicted on berries are also higher than those found in similar forest plants (USDA, 1984). In addition, the levels predicted for deer in the routine-realistic scenario are similar to the highest levels found by Newton and Norris (1968, as cited in Dost, 1983), who did not find levels greater than 0.08 parts per million in edible deer tissues.

Risk to the Public Under Routine-Worst Case Scenarios

The routine-worst case scenarios described in Section 3 were intended to indicate the upper bound for public exposure to herbicide applications in California. The low probability of each assumption, which would apply to all of the events that led to the exposures described in Table H-25, must be emphasized. It is extremely unlikely that anyone would receive a dose as high as those estimated here.

Margins of Safety Under Routine-Worst Case Scenarios. Table H-25 indicates that most margins of safety projected under this routine-worst case scenario are greater than 50 except for amitrole, 2,4-D, and triclopyr. Under these extreme assumptions, risk to individuals is very low except for people who receive multiple exposures from a 400-acre fixed-wing application. Margins of safety calculated for combined routes of exposure to 2,4-D and triclopyr were all within 10 to 50 in the worst case aerial application. Chronic doses of 2,4-D, as predicted by this analysis, could affect the peripheral nervous system which, in most cases, would be a reversible effect. For triclopyr, people who chronically receive doses predicted here could experience kidney problems. Because the margins of safety were computed by comparing acute exposures with chronic no-effect levels, the risk of occurrence of these effects can be considered extremely low, especially considering the extreme unlikelihood of nearby residents receiving repeated doses over the long term. The margin of safety derived for triclopyr also is extremely conservative because the toxic effects observed in dogs that resulted in a systemic NOEL of 2.5 mg/kg/day may have been exacerbated by the decreased renal excretion capacity of dogs, which is not representative of human renal physiology. Feeding studies in other test species did not result in kidney problems or other toxic effects at a higher dose level (30 mg/kg/day) (USDA, 1984).

The margins of safety computed for the residents in the worst case 400-acre aerial spray site indicate that sensitive individuals could suffer some acute toxic effects from the predicted exposures to atrazine, 2,4-D, and triclopyr. For atrazine, all margins of safety are greater than 50 except for a berrypicker who is dermally exposed for 4 hours, eats 0.9 pounds of berries and drinks a liter of water contaminated at the highest possible level. This person could experience some systemic effects. However, that is unlikely because these are one-time doses and are all more than 10,000 times lower than the LD_{50}. It should be noted that the systemic NOEL for atrazine is based on weight loss in dogs. Therefore, sensitive individuals could become ill and possibly experience stomach problems.

Public MOSs for all 16 herbicides are presented in Attachment C. MOSs for the doses estimated in the routine-worst case public exposure scenarios for the three most heavily used herbicides--2,4-D, picloram, and triclopyr--begin in Tables C-54, C-90, and C-104, respectively.

Probability of the Routine-Worst Case Doses Occurring. The probability of someone receiving a dose as high as those predicted under the routine-worst case scenario is negligible. The probability is low because this scenario assumes that a number of unlikely events occur simultaneously. For example, using the assumptions that the probability of treating a unit as big as 400 acres is 1 in 100, and the probability of the high drift case is 1 in 100, and the probability of someone being in the vicinity of the treatment area is 1 in 100, then the probability of someone receiving a dose as high as those predicted here is 1 in 1 million (0.01 x 0.01 x 0.01 = 0.000001). In fact, historical records indicate that the probability of these events occurring simultaneously is less than this.

Risk to the Public Under Accidental Scenarios

Table H-26 summarizes the risk to the public from direct exposure to aerial applications or from eating food or drinking water that has been directly hit at the highest application rate. The relatively low margins of safety for amitrole, atrazine, bromacil, 2,4-D, diuron, and triclopyr indicate that people exposed to a direct aerial application or exposed to items that received the highest application rate could experience some toxic effects. The extent of effects would depend upon their duration of exposure and any

Table H-26
Margins of Safety Less Than 10 for the General Public in the Accidental-Worst Case Scenarios

Herbicide	MOS Less Than 10	
	Items Sprayed at Full Application Rate	Spill
Amitrole	All exposures except vegetation vegetation contact by the hiker are less than 10. Doses from all other routes except eating deer meat exceed the NOEL.	Doses from truck spill into pond and from truck spill into reservoir exceed the NOEL.
Asulam	None less than 10 for either scenario.	
Atrazine	Vegetation contact by berrypicker; combined exposure routes for hiker, berrypicker, hunter, fisherman, and resident.	Truck spill into pond.
Bromacil	Vegetation contact by the berrypicker, combined exposures for berrypicker, hunter, fisherman, and resident.	Truck spill into pond.
2,4-D	Vegetation contact by berrypicker, combined exposure routes for hiker, berrypicker, hunter, fisherman, and resident.	Truck spill into pond dose exceeds NOEL.
2,4-DP	Only MOS for combined exposure less than 10.	Truck spill into pond.
Dalapon	Only the combined exposure berrypicker MOS is less than 10.	Truck spill into pond.

Table H-26 (Cont.)

Herbicide	MOS Less Than 10	
	Items Sprayed at Full Application Rate	Spill
Dicamba	Combined exposure of the the berrypicker.	Truck spill into pond.
Diuron	All margins of safety, except hiker vegetation contact and person eating deer are less than 10. The berrypicker vegetation contact and eating fish exposures and all combined exposures exceed the systemic NOEL.	Truck spill into pond dose exceeds NOEL.
Fosamine	None less than 10.	Truck spill into pond.
Glyphosate	None less than 10.	Truck spill into pond.
Hexazinone	Only the combined exposure berrypicker MOS is less than 10.	Truck spill into pond.
Picloram	None less than 10.	Truck spill into pond.
Simazine	Berrypicker vegetation contact and combined routes for berrypicker.	Truck spill into pond.
Tebuthiuron	None less than 10.	Truck spill into pond.
Triclopyr	Vegetation contact by the berrypicker; combination exposure for hiker, hunter, fisherman, and resident.	Truck spill into pond dose exceeds NOEL.

precautionary measures that were taken. For example, if people gathered a bushel of berries from a spray area and did not wash them but froze them and then ate them every day for a month, they might feel quite ill. However, if people bathed after being in the forest or washed food items before eating them, the doses would drop (and thus increase the margins of safety) substantially.

The risk of a member of the public being directly hit by an aerial spray operation is very small. The probability of a pesticide application in an area not scheduled for treatment is low. According to the Forest Service data on insecticide application (USDA, 1984), the probability, based on empirical data, of some kind of significant error in a pesticide application is 0.0002 (at the 95-percent confidence level). Operational features of herbicide operations make the probability of applying a herbicide in an area not scheduled for treatment less than that of insecticide operations. Using this value as an extremely conservative estimate of the probability of an application directly hitting a human being, there might be three accidents over a period of 8 years if a spraying operation occurred every day for 6 months during each of those years. In addition, the probability that someone will be in the area being sprayed is very low because normally the area is posted before spraying and humans will be kept out of the treated areas during spray operations. Thus, the probability of such accidents can be considered negligible.

Again it must be noted that these are one-time, rather than repeat or chronic, exposures and that the comparison of these doses with the acute LD_{50}s shows that no one is at risk of fatal effects. Complete margins of safety computed for each chemical and application under the accidental worst-case scenario are presented in Attachment C.

Risk to the Public from Herbicides Used in Brown and Burn Operations

Brown and burn operations may be conducted on approximately 1,700 acres of BLM land every year. These operations are generally limited to chaparral vegetation and often steep terrain. 2,4-D accounts for approximately 75 percent of the total herbicide used during this type of operation. Glyphosate and triclopyr are used to a much lesser extent. Typically, the selected herbicide is applied aerially in the fall and the vegetation is not burned until the following spring, approximately 5 to 7 months later. However, in some cases burning may take place as soon as 2 weeks after the herbicide has been applied. The treatment units average approximately 30 acres. Crew size at any given site may vary from 10 to 26 workers during the burning operation.

To estimate worker exposure during these operations, it is necessary to calculate the amount of herbicide that will be remaining on the vegetation at the time of burning. The half-lives for 2,4-D, glyphosate, and triclopyr are 16, 14, and 18 days, respectively. Therefore, after 2 weeks, residues of the amount of applied herbicides would remain on the vegetation: 54 percent of 2,4-D, 50 percent of glyphosate, and 58 percent of triclopyr.

The following assumptions were used to calculate potential worker exposure to smoke:

1. 32 metric tons (32,000 kg) of fuel per acre
2. 40 percent of the available fuel by weight is burned
3. Smoke density is 5 mg/m^3 (visibility 100 m)
4. 8.5 g smoke/kg of fuel burned
5. 30 acres per average treatment unit
6. All herbicide residue is released to the atmosphere upon burning
7. Respiration rate for workers at moderate work is 29 liters per minute or 1.74 m^3 per hour

32,000 kg/acre * 0.40 = 13,000 kg of fuel per acre

13,000 kg * 8.5 g/kg = 110,000 g of smoke produced per acre

110,000 g/(5 mg/m^3) = 22,000,000 m^3 of smoke per acre

22,000,000 m^3 * 30 acres = 6.6×10^8 m^3 of smoke per treatment unit

__2,4-D__. The number of kilograms of 2,4-D applied at 5.7 lb/acre is:

5.7 lb / (2.2 lb/kg) = 2.6 kg

The amount of 2,4-D available after 2 weeks is:

2.6 kg * .54 = 1.4 kg of 2,4-D per acre.

The atmospheric concentration of 2,4-D is:

1.4×10^6 mg / 2.2×10^7 m^3 = .0636 mg/m^3

The expected dose of 2,4-D for an average worker (50 kg body weight) respiring at a rate of 1.74 m^3/hour is:

(.0636 mg/m^3 * 1.74 m^3/hour) / 50 kg = 2.2×10^{-3} mg/kg/hour.

This is far below the NOEL of 1.0 mg/kg/day. A 1-hour-per-day exposure to smoke of this density is a reasonable expectation. If a worker were exposed to 3 hours of smoke per day, the dose would be only 3 times greater than that calculated and would still be well below the NOEL. A worker is not typically exposed to brown and burn operations more than 12 days per year. Therefore, the overall health risk from this type of operation with 2,4-D is negligible.

__Glyphosate__. The number of kilograms of glyphosate applied at 5.0 lb/acre is:

5.0 lb/(2.2 lb/kg) = 2.3 kg

The amount of glyphosate available after 2 weeks is:

2.3 kg * .50 = 1.15 of glyphosate per acre.

The atmospheric concentration of glyphosate is:

1.15×10^6 mg / 2.2×10^7 m^3 = .0523 mg/m^3.

The expected dose of glyphosate for an average worker (50 kg body weight) respiring at a rate of 1.74 m^3/hour is:

$$(.0523\ mg/m^3 * 1.74\ m^3/hour)\ /\ 50\ kg = 1.82 \times 10^{-3}\ mg/kg/hour.$$

This dose is well below the NOEL of greater than 31 mg/kg/day and should pose no risk to health.

Triclopyr. The number of kilograms of triclopyr at a maximum application rate of 8.0 lb/acre is:

$$8.0\ /\ (2.2\ lb/kg) = 3.6\ kg$$

The amount of triclopyr available after 2 weeks is:

$$3.6\ kg * .58 = 2.09\ kg$$

The atmospheric concentration of triclopyr is:

$$2.09 \times 10^6\ mg\ /\ 2.2 \times 10^7\ m^3 = .095\ mg/m^3$$

The expected dose of triclopyr for an average worker (50 kg body weight) respiring at a rate of 1.74 m^3/hour is:

$$(.095\ mg/m^3 * 1.74\ m^3/hour)\ /\ 50\ kg = 3.31 \times 10^{-3}\ mg/kg/hour.$$

This dose is insignificant and is far below the NOEL of 2.5 mg/kg/day. No adverse health effects are expected.

Combustion Project. Wall et al. (1984) studied the pyrolysis products of 2,4-D and glyphosate. At 800°C 2,4-D volatilized and condensed upon cooling. Approximately 2.5 percent was converted to 2,4-dichlorophenol. No other significant pyrolysis products were formed.

Temperatures during the burning of vegetation are expected to reach at least 1,000 degrees Celsius, which could cause considerable breakdown of the herbicides (Kennedy et al., 1969). Glyphosate was almost completely destroyed at 800 degrees and largely converted to CO_2. Approximately 5 to 6 percent of the glyphosate was converted to volatile byproducts, including primarily acetonitrile, alkylpyridines, and alkylpyrazines. To a lesser extent benzene, toluene, and acetic acid were formed. No information on the combustion of triclopyr is available.

Cancer Risk from Burning Vegetation

Dost (1986) has performed a cancer risk assessment of the main carcinogens found in wood smoke, the polynuclear aromatic hydrocarbons (PAHs). This chemical group includes benzo(a)pyrene (BaP), a known human carcinogen with a cancer potency of .0033. Other PAHs in wood smoke which have shown to be carcinogenic in laboratory animal studies include benzo(c)phenanthrene, benzofluoranthrene, 3-methyl-cholanthrene, and dimethylbenzanthrene. These all have potencies less than or equal to BaP.

Dost used the following assumption in estimating BaP exposure:

- 2,500 mg BaP is released from every kg of fuel that is burned (EPA finds this number sufficiently conservative).

- All BaP is incorporated into fine particulate matter that is of respirable size and 8,500 mg of particulate is produced per kg of fuel that is burned (the Forest Service frequently employs this number).
- Smoke density is 0.155 mg/m^3 based on a visibility of 2 miles.
- A person is exposed for 6 hours per day, 20 days per year, for 10 years of his lifetime.

Based on these assumptions, the average lifetime exposure concentration would be 9.1 x 10^{-5} ug/m^3 of BaP. The increased cancer risk due to BaP would be 3 x 10^{-7} or 3 in 10,000,000.

Dost completed similar calculations for the four other carcinogenic PAHs. The total increased risk of cancer from the PAHs, including BaP, is 1.1 x 10^{-6}.

Therefore, based on these assumptions there is very little risk of adverse health effect from exposure to weed smoke from BLM burning operations.

Risk to Workers from Routine Operations

Tables H-27 to H-30 summarize the margins of safety for workers based on the systemic and reproductive NOELs for the 16 herbicides. Full tables showing margins of safety computed for the 16 herbicides are presented in Attachment C, Tables C-1 through C-144. Because of the assumptions that were made to overestimate risk, the BLM estimates that almost all of the operations that take place will fall within the values predicted for the routine-realistic scenarios. Routine-worst case estimates are presented to show the upper bound or 95-percent confidence level of risk to workers.

It must be emphasized that the routine worker exposures and resultant margins of safety are what could be expected in the majority of vegetation management programs in California for workers not wearing protective clothing or equipment. All of the studies from which the routine-realistic exposures were calculated are based on workers wearing no protective clothing. The use of protective clothing can substantially reduce worker doses, as shown in field studies of worker exposure, and thereby increase their margins of safety.

Effects of the Use of Protective Clothing

Protective clothing can reduce worker exposures by 27 to 99 percent as shown in a number of relevant field studies. The calculated doses presented below were based on the assumption that workers work with bare hands and wear ordinary work clothing, such as cotton pants and short-sleeve shirts. It is common practice, however, for herbicide applicators to wear clothing that affords more protection. Typical clothing often includes long-sleeve shirts or coveralls, gloves and hats.

Research has shown that such protective clothing can substantially reduce worker exposure. For example, in right-of-way spraying, doses of spray gun applicators wearing clean coveralls and gloves were reduced by 68 percent compared to the doses they got without this protection (Libich et al., 1984) During an aerial spraying operation, mixer/loaders wearing protective clothing reduced their exposure by 27 percent and other crew members reduced their exposure by 58 percent compared to the levels observed without precautions (Lavy et al., 1982).

During insecticide applications to orchards, mixers reduced their exposure by 35 percent and sprayers reduced their exposure by 49 percent by wearing coveralls (Davies et al., 1982). Putnam and co-workers found that nitrofen applicators and mixer/loaders wearing protective clothing reduced their exposure by 94 to 99 percent compared to the doses experienced without protection (Waldron, 1985). Although protective clothing generally does reduce worker exposure and resulting doses, the degree of protection depends on the application system, the work practices, and the specific herbicide. In one extreme case, workers wearing protective clothing did not receive significantly lower doses than workers with less clothing (Lavy et al., 1984). In this case backpack applicators had to treat and move through dense vegetation that was taller than themselves.

Most exposure to herbicide applicators is dermal, not inhalation (Kolmodin-Hedman, et al., 1983), so the use of respirators is ineffective and unnecessary. The hands are the site of the greatest potential herbicide exposure, and rubber gloves are generally quite effective in preventing exposure to hands (Putnam et al., 1983).

Based on the review of field studies protective clothing was normally found to reduce worker doses by the following amounts:

Type of Worker	Percent Reduction in Dose
1. Right-of-way applicators	68.1
2. Aerial application crew members	57.1
3. Aerial mixer/loaders	27.1
4. Injection bar applicators	54.7
5. Hack-and-squirt applicators	57.6

Doses to protected backpack applicators were based on doses to right-of-way applicator who used hand-held nozzles. Tables H-27 and H-28 list routine-realistic margins of safety computed for workers without protective clothing and for workers with protective clothing in parentheses. Tables H-29 and H-30 list the same values for routine-worst case doses.

Risk to Workers Under Routine-Realistic Scenarios

In the routine-realistic scenario, all categories of workers applying asulam or picloram have MOSs greater than 100. This indicates that even workers chronically exposed to these herbicides should suffer no ill effects. For all the other herbicides, as shown in Tables H-27 and H-28, at least one category of worker (primarily backpack sprayers) had MOSs less than 100 in the routine-realistic scenario. This means that unprotected sensitive workers that routinely receive doses this high may experience some toxic effects from applying these herbicides in certain situations.

Backpack sprayers are clearly at greatest risk based on comparisons of estimated doses with systemic and reproductive NOELs for all of the herbicides. Hand applicators are next, while pilots and mixer-loaders are at somewhat lower risk. Observers and right-of-way applicators are at least risk.

Except for backpack sprayers using asulam or picloram, all backpack sprayers have margins of safety less than 100. Amitrole, atrazine, bromacil, 2,4-D, and triclopyr have MOSs less than 10; and in the case of diuron, the dose exceeds the NOEL. The doses and margins of safety are based on 6 hours per day of exposure. Any reduction in the time of exposure would reduce the dose and increase the margin of safety proportionally.

Diuron appears to be the herbicide presenting the greatest risk from repeated exposures. Backpack sprayers using diuron in the routine-realistic scenario receive a dose that is less than the systemic NOEL. Diuron systemic MOSs for hack-and-squirt applicators are also less than 10 in the routine-realistic case.

2,4-D presents the next highest long-term risk. Backpack sprayers using 2,4-D in the routine-realistic scenarios receive doses that have systemic margins of safety less than 10. Pilots, mixer/loaders, and both types of hand applicators have MOSs less than 50.

Amitrole and triclopyr have at least four margins of safety for workers (including those for backpack sprayers) that are less than 100.

Risk to Workers Under Routine-Worst Case

As shown in Tables H-29 and H-30, a number of herbicides have margins of safety less than 10 in the routine-worst case scenario.

Backpack sprayers using diuron, triclopyr, 2,4-D, or amitrole in the routine-worst case scenario receive doses that exceed their respective systemic NOELs. In addition, doses calculated for truck applicators and hack and squirt applicators using diuron exceed the systemic NOEL. Margins of safety for the reproductive NOELs are much higher. No applicator dose exceeds the reproductive NOEL for any herbicide in any situation.

All categories of workers, except the aerial supervisor and observer, have margins of safety less than 10 for at least one of the herbicides. Picloram and asulam are the only herbicides that have margins of safety greater than 20 for all categories of workers.

The probability of workers receiving repeated daily doses as high as predicted here is extremely low (less than 1 chance in 1,000). Therefore, even if a worker were to feel ill for a day or so from an unusually high dose, he would not be expected to suffer permanent damage. The vast majority of the time workers will be receiving doses less than those predicted in the routine-realistic scenario. Sensitive individuals would be at greater risk.

The routine-worst case analysis for workers is based on a series of assumptions that, acting together, greatly increase the estimated risk. It uses the upper 2.5 percent of doses received in field studies, the highest application rates used by BLM and the longest work hours for each type of project.

Table H-27
Worker Margins of Safety for Reproductive Effects
Routine-Realistic Scenarios

	Aerial				Back Pack	Truck			Hand Application	
Herbicide	PILOT	MIX/L	SUP	OBS	BP	APPL	MIX/L	APPL MIX/L	H&S	INJ BAR
Amitrole	--	--	--	--	++(++)	++(++)	++(++)	++(++)	++(++)	++(++)
Asulam	--	--	--	--	250(810)	++(++)	++(++)	++(++)	--	--
Atrazine	++(++)	920(++)	++(++)	++(++)	200(650)	++(++)	++(++)	++(++)	--	--
Bromacil	--	--	--	--	12(38)	580(++)	570(780)	410(790)	71(170)	190(410)
2,4-D	170(++)	120(160)	++(++)	++(++)	26(82)	++(++)	++(++)	++(++)	74(180)	200(++)
2,4-DP	--	--	--	--	30(95)	++(++)	++(++)	810(++)	58(140)	150(340)
Dalapon	--	--	--	--	450(++)	++(++)	++(++)	++(++)	--	--
Dicamba	--	--	--	--	61(190)	++(++)	++(++)	++(++)	45(110)	120(260)
Diuron	--	--	--	--	9.5(30)	460(++)	450(610)	320(620)	56(130)	150(330)
Fosamine	--	--	--	--	++(++)	++(++)	++(++)	++(++)	++(++)	++(++)
Glyphosate	--	--	--	--	40(130)	++(++)	++(++)	++(++)	--	--
Hexazinone	++(++)	++(++)	++(++)	++(++)	680(++)	++(++)	++(++)	++(++)	--	--
Picloram	++(++)	++(++)	++(++)	++(++)	++(++)	++(++)	++(++)	++(++)	++(++)	++(++)
Simazine	--	--	--	--	15(49)	730(++)	720(980)	520(++)	--	--
Tebuthiuron	--	--	--	--	360(++)	++(++)	++(++)	++(++)	--	--
Triclopyr	250(590)	170(240)	++(++)	++(++)	30(97)	++(++)	++(++)	++(++)	90(210)	240(520)

Numbers in parentheses refer to margins of safety for workers wearing protective clothing.

MIX/L = Mixer/Loader
SUP = Supervisor
OBS = Observer
BP = Backpack
APPL = Sprayer
H&S = Hack and Squirt
INJ BAR = Injection Bar
++ = MOS of 1000 or more
-- = Not used in respective operation

Table H-28
Worker Margins of Safety for Systemic Effects
Routine-Realistic Exposures

	Aerial				Back Pack	Truck			Hand Application	
Herbicide	PILOT	MIX/L	SUP	OBS	BP	APPL	MIX/L	APPL MIX/L	H&S	INJ BAR
Amitrole	—	—	—	—	7.6(24)	360(++)	360(490)	260(500)	45(110)	120(260)
Asulam	—	—	—	—	300(810)	++(++)	++(++)	++(++)	—	—
Atrazine	49(120)	34(47)	320(760)	++(++)	7.5(24)	360(++)	350(480)	260(490)	—	—
Bromacil	—	—	—	—	9.5(30)	460(++)	450(610)	320(620)	56(130)	150(330)
2,4-D	33(79)	23(32)	220(520)	++(++)	5.1(16)	190(620)	190(260)	140(270)	15(35)	39(87)
2,4-DP	—	—	—	—	24(76)	910(++)	890(++)	650(++)	47(110)	120(270)
Dalapon	—	—	—	—	23(73)	++(++)	++(++)	780(++)	—	—
Dicamba	—	—	—	—	610(++)	++(++)	++(++)	++(++)	450(++)	++(++)
Diuron	—	—	—	—	-1.1(3.0)	46(150)	45(61)	32(62)	5.6(13)	15(33)
Fosamine	—	—	—	—	51(160)	++(++)	++(++)	++(++)	220(530)	590(++)
Glyphosate	—	—	—	—	130(410)	++(++)	++(++)	++(++)	—	—
Hexazinone	200(470)	140(190)	++(++)	++(++)	54(170)	++(++)	++(++)	830(++)	—	—
Picloram	++(++)	++(++)	++(++)	++(++)	880(++)	++(++)	++(++)	++(++)	++(++)	++(++)
Simazine	—	—	—	—	15(49)	730(++)	720(980)	520(++)	—	—
Tebuthiuron	—	—	—	—	51(160)	++(++)	++(++)	++(++)	—	—
Triclopyr	62(150)	43(59)	410(970)	++(++)	7.6(24)	360(++)	360(490)	260(500)	22(53)	59(130)

Numbers in parentheses refer to margins of safety for workers wearing protective clothing.

MIX/L = Mixer/Loader
SUP = Supervisor
OBS = Observer
BP = Backpack
APPL = Sprayer
H&S = Hack and Squirt
INJ BAR = Injection Bar
++ = MOS of 1000 or more
— = Not used in respective operation

Table H-29
Worker Margins of Safety for Reproductive Effects
Routine-Worst Case Scenarios

	Aerial				Back Pack	Truck			Hand Application	
Herbicide	PILOT	MIX/L	SUP	OBS	BP	APPL	MIX/L	APPL MIX/L	H&S	INJ BAR
Amitrole	—	—	—	—	160(520)	++(++)	++(++)	++(++)	790(++)	++(++)
Asulam	—	—	—	—	24(77)	190(600)	330(450)	280(540)	—	—
Atrazine	150(360)	120(160)	860(++)	++(++)	40(130)	220(710)	380(530)	330(630)	—	—
Bromacil	—	—	—	—	1.3(4.1)	15(48)	26(36)	22(43)	6.3(15)	23(52)
2,4-D	12(30)	9.8(13)	72(172)	++(++)	3.4(11)	38(120)	66(92)	56(110)	6.6(16)	24(54)
2,4-DP	—	—	—	—	3.7(12)	37(120)	64(88)	55(100)	5.2(12)	19(43)
Dalapon	—	—	—	—	40(130)	570(++)	980(++)	840(++)	—	—
Dicamba	—	—	—	—	2.0(6.5)	26(84)	45(62)	39(75)	4.0(9.3)	15(33)
Diuron	—	—	—	—	1.7(5.4)	7.4(24)	13(18)	11(21)	5.0(12)	19(41)
Fosamine	—	—	—	—	73(230)	++(++)	++(++)	++(++)	390(++)	++(++)
Glyphosate	—	—	—	—	3.2(10)	38(120)	65(90)	56(110)	—	—
Hexazinone	250(590)	200(270)	++(++)	++(++)	67(220)	390(++)	680(930)	580(++)	—	—
Picloram	++(++)	980(++)	++(++)	++(++)	420(++)	++(++)	++(++)	++(++)	++(++)	++(++)
Simazine	—	—	—	—	1.8(5.6)	20(66)	36(49)	30(58)	—	—
Tebuthiuron	—	—	—	—	24(78)	370(++)	640(880)	550(++)	—	—
Triclopyr	7.5(18)	5.9(8.0)	43(100)	240(580)	2.0(6.5)	24(76)	41(56)	35(67)	7.9(19)	30(65)

Numbers in parentheses refer to margins of safety for workers wearing protective clothing.

MIX/L = Mixer/Loader
SUP = Supervisor
OBS = Observer
BP = Backpack
APPL = Sprayer
H&S = Hack and Squirt
INJ BAR = Injection Bar
++ = MOS of 1000 or more
— = Not used in respective operation

Table H-30
Worker Margins of Safety for Systemic Effects
Routine-Worst Case Scenarios

	Aerial				Back Pack	Truck			Hand Application	
Herbicide	PILOT	MIX/L	SUP	OBS	BP	APPL	MIX/L	APPL MIX/L	H&S	INJ BAR
Amitrole	—	—	—	—	-1.2(2.6)	5.9(19)	10(14)	8.7(17)	4.0(9.3)	15(33)
Asulam	—	—	—	—	29(77)	230(600)	390(450)	340(540)	—	—
Atrazine	5.5(13)	4.3(5.9)	32(76)	180(430)	1.5(4.8)	8.2(26)	14(20)	12(23)	—	—
Bromacil	—	—	—	—	1.0(3.2)	12(38)	20(28)	17(34)	5.0(12)	19(41)
2,4-D	2.5(5.9)	2.0(2.7)	14(34)	81(190)	-1.5(2.2)	7.7(25)	13(18)	11(22)	1.3(3.1)	4.9(11)
2,4-DP	—	—	—	—	2.9(9.4)	29(94)	51(70)	44(84)	4.1(9.7)	15(34)
Dalapon	—	—	—	—	2.0(6.5)	28(91)	49(67)	42(81)	—	—
Dicamba	—	—	—	—	20(64)	260(840)	450(620)	390(740)	40(94)	150(320)
Diuron	—	—	—	—	-5.9(-1.9)	-1.4(2.4)	1.3(1.8)	1.1(2.1)	-2.0(1.2)	1.9(4.1)
Fosamine	—	—	—	—	3.5(11)	44(140)	76(100)	65(130)	20(47)	74(160)
Glyphosate	—	—	—	—	10(32)	110(370)	208(280)	180(330)	—	—
Hexazinone	20(48)	16(21)	110(270)	650(++)	5.4(17)	31(100)	54(75)	47(90)	—	—
Picloram	170(420)	140(190)	++(++)	++(++)	59(190)	++(++)	++(++)	++(++)	230(550)	860(++)
Simazine	—	—	—	—	1.8(5.6)	20(66)	36(49)	30(58)	—	—
Tebuthiuron	—	—	—	—	3.4(11)	51(160)	89(120)	76(150)	—	—
Triclopyr	1.9(4.5)	1.5(2.0)	11(26)	60(140)	-2.0(1.6)	5.9(19)	10(14)	8.7(17)	2.0(4.7)	7.4(16)

Numbers in parentheses refer to margins of safety for workers wearing protective clothing.

MIX/L = Mixer/Loader
SUP = Supervisor
OBS = Observer
BP = Backpack
APPL = Sprayer
H&S = Hack and Squirt
INJ BAR = Injection Bar
++ = MOS of 1000 or more
— = Not used in respective operation

If we combine the probability of getting a dose above the upper 95 percent confidence level of field studies (1 in 40), with a probability of using the highest application rate of 1 in 20, and a probability of someone working the maximum hours of 1 in 20. then the probability of a worker getting a dose as high as predicted here is 1 in 16,000. (1/40 x 1/20 x 1/20 = 1/16,000).

Risk to Workers from Spilling Concentrate or Spray Mix on Their Skin

It must be noted at the outset when considering the effects resulting from these types of accidents that the doses estimated here are based on dermal penetration levels derived in studies over many days; these chemicals do not penetrate the skin immediately but over a considerable period of time. Thus, workers would have to ignore their own safety and not wash the chemical off to receive doses as high as predicted in these accidents.

For workers who spill a pint of concentrate or spray mix on their skin there is a clear possibility that, with the exception of picloram, they could experience some acute toxic effects if they did not wash it off. The margins of safety for this accidental-worst case scenario are presented in Table H-31. In the case of a spill of a pint of concentrate, many of the doses approach the LD_{50}. This represents a clear risk of severe toxic effects if the chemical is not washed off. There is some possibility that the damage caused by such a large acute dose could cause long-term damage to vital organs. There have also been rare instances in which limited exposure to 2,4-D was reported to cause permanent nerve damage. The dose and the risk are much greater for spills of concentrate than for the spray mix but, again, it is highly unlikely a worker would allow the chemical to penetrate his skin for any length of time. Attachment C presents the complete MOS and comparisons to LD_{50}s for each herbicide.

Risk to Workers and the Public from Accidents Causing Large Spills of Herbicide

Table H-32 summarizes the margins-of-safety for people drinking one liter of water contaminated by a large spill of herbicide from a helicopter or truck (see Attachment C, Tables C-123 through C-144). Most drinking water reservoirs would dilute the herbicide below no-observable-effect levels in a relatively short period of time. BLM, EPA, and the states have procedures to minimize the risk to human health should a spill of this magnitude occur in or near a drinking water reservoir. Therefore, after the spill has been diluted, the risk to members of the public can be considered very low.

Spills into a small, stagnant pond would result in significantly higher doses and, in the event of a truck spill of 2,000 gallons would constitute a risk of chronic effects if members of the public continued to drink from it. The BLM has detailed spill prevention and cleanup procedures to ensure that no member of the public is chronically exposed to a spill of this magnitude.

Table H-31
Margins of Safety for Spills onto the Skin of Workers Compared to Systemic NOELs and LD_{50}s

	Spray Mix		Concentrate	
Herbicide	NOEL	LD_{50}	NOEL	LD_{50}
Amitrole	-9.6	17,000	-48	3,400
Asulam	3.0	200	-4.0	17
Atrazine	-6.5	78	-65	7.8
Bromacil	-9.6	330	-38	17
2,4-D	-14	26	-140	2.6
2,4-DP	-1.9	55	-46	2.3
Dalapon	-4.0	130	--	--
Dicamba	2.1	63	-4.8	6.3
Diuron	-31	200	-380	16
Fosamine	-2.9	340	-9.6	100
Glyphosate	-1.0	140	-6.2	24
Hexazinone	-1.8	94	-12	14
Picloram	4.9	5,700	1.2	1,400
Simazine	-6.0	170	-48	21
Tebuthiuron	-2.9	18	--	--
Triclopyr	-19	13	-96	2.6

Table H-32
Margins of Safety for People Drinking One Liter of Water Contaminated by a Large Spill of Herbicide[a] Compared to the Systemic NOEL

	Helicopter		Truck	
Herbicide	Into a Reservoir	Into a Pond	Into a Reservoir	Into a Pond
Amitrole	--	--	-1.8	-59
Asulam	--	--	1,600	49
Atrazine	1600	50	80	2.5
Bromacil	--	--	270	8.5
2,4-D	430	14	22	-1.5
2,4-DP	--	--	170	5.4
Dalapon	--	--	130	4.1
Dicamba	--	--	540	17
Diuron	--	--	17	-1.9
Fosamine	--	--	180	5.7
Glyphosate	--	--	1000	34
Hexazinone	5,800	180	290	9.1
Picloram	2,400	76	120	3.8
Simazine	--	--	87	2.7
Tebuthiuron	--	--	180	5.7
Triclopyr	540	17	27	-1.2

[a] Assume a helicopter carrying 100 gallons of spray mix jettisons the entire load in a 16-acre by 8-foot-deep reservoir and a 1-acre by 4-foot-deep pond.

Probability of a Worst Case Accident

Some indication of the likelihood of significant herbicide spill accidents occurring may be derived from historical data. Herbicide spill accidents recorded by BLM and the Forest Service over 11 years were classified by location, date, and quantity spilled. Also included was information specifying the occurrence of accidents on the ground or in the air, and if the spill was near a waterway. Over an 11-year period, from 1973 through 1983, there were 24 recorded spills averaging 44.4 gallons per accident. Herbicide use rates ranged from 1.5 lb a.i. to 7 lb a.i. per acre for normal use rates. For a total of 302,085 acres sprayed during the 11-year period there was one accident for every 12,587 acres and 54 percent of the spills involved 30 gallons or less.

Table H-33 shows the acreage sprayed, gallons spilled, and type of spill for the years 1973 to 1983. Figures H-4 and H-5 show that as the number of gallons increases, the probability of a spill decreases.

CANCER RISK

A worst-case analysis for cancer was conducted for the herbicides that had positive laboratory oncogenic studies (amitrole, asulam, atrazine, bromacil, and 2,4-DP) and for the herbicides (2,4-D, glyphosate, and picloram) for which there is scientific uncertainty. There is no evidence to suggest that any of the other herbicides could cause cancer. All of the other herbicides have negative cancer studies. EPA has requested additional data on the cancer potential of a number of the other 8 herbicides, and BLM will consider the results of their findings when they become available.

Cancer is generally thought of as a nonthreshold response, which means a very small amount could cause a tumor and there is general agreement that amitrole has the potential to cause cancer in humans. In the case of amitrole, however, EPA has determined that the available evidence indicates a threshold carcinogenic response. A threshold response is consistent with the theory that amitrole is a secondary carcinogen because of its well-established anti-thyroid effects. Nevertheless, because there is some uncertainty about the mechanism of action of amitrole, a conservative approach has been taken in this analysis by assuming that amitrole's carcinogenicity is not a threshold effect. A threshold model would indicate zero or negligible carcinogenicity at low doses. This would be true of the log-probit model suggested by EPA (EPA, 1984s), but instead, the one-hit model has been used here under the assumption that even low doses may cause cancer. The one-hit model used for estimating the risk for all herbicides in this analysis predicts the maximum rates of cancer that could occur at low doses under any of the models that have been in general use. At high doses, all of the commonly used models would predict nearly the same rate of tumor formation.

Cancer risks for amitrole, asulam, atrazine, bromacil, 2,4-DP, 2,4-D, glyphosate, and picloram have been calculated based on a variety of conservative assumptions that are likely to overestimate the risks. These assumptions include the following:

Table H-33
Number of Spills on Forest Service Land in
Washington and Oregon over the Last 10 Years

Number of Gallons	Number Spills (air and ground)	Avg. No. of Spills/ 1,000 Acres	Number Spills (air)	Avg. No. of Spills/ 1,000 Acres
0	24	0.0795	9	0.0298
10	19	0.0629	9	0.0298
20	14	0.0464	6	0.0199
30	11	0.0364	5	0.0166
40	11	0.0364	5	0.0166
50	10	0.0331	4	0.0132
60	8	0.0265	4	0.0132
70	6	0.0199	2	0.0066
80	6	0.0199	2	0.0066
90	3	0.0099	2	0.0066
100	1	0.0033	0	0.0000

1. Amitrole, asulam, atrazine, bromacil, 2,4-DP, glyphosate, picloram, and 2,4-D are all assumed to be carcinogenic. Picloram and 2,4-D have not been shown conclusively to be carcinogenic in laboratory tests and there are many uncertainties about the glyphosate study, but the evidence also cannot show conclusively that they are not carcinogenic. Consequently, a worst case approach was taken.

2. In cases where there is more than one data set available, the data set indicating greater carcinogenic potency has been chosen. Carcinogenic potencies of 2,4-D and 2,4-DP have been calculated based on the rate of tumor formation in the female Osborne-Mendel rats studied by Hansen et al. (1971). This is the species and sex that have exhibited the highest rate of tumor formation after 2,4-D administration. All tumors were considered, although many of them were benign. Similarly for amitrole, the Food and Drug Research Laboratories rat study data (discussed in Section 2) have been used.

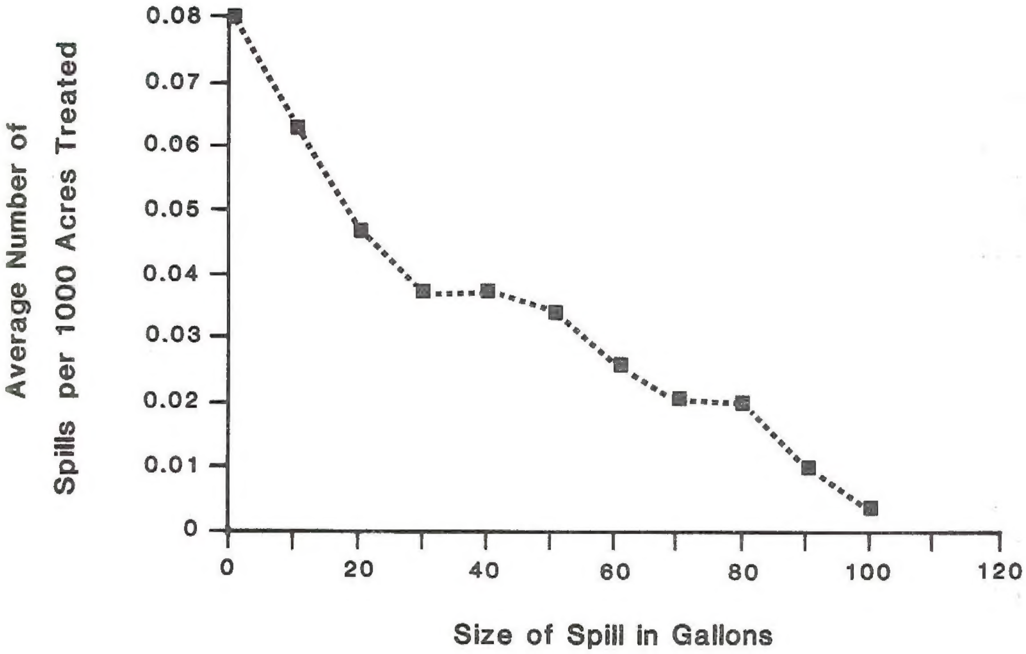


Figure H-4 Frequency and Size of Spills from Air and Ground Operations

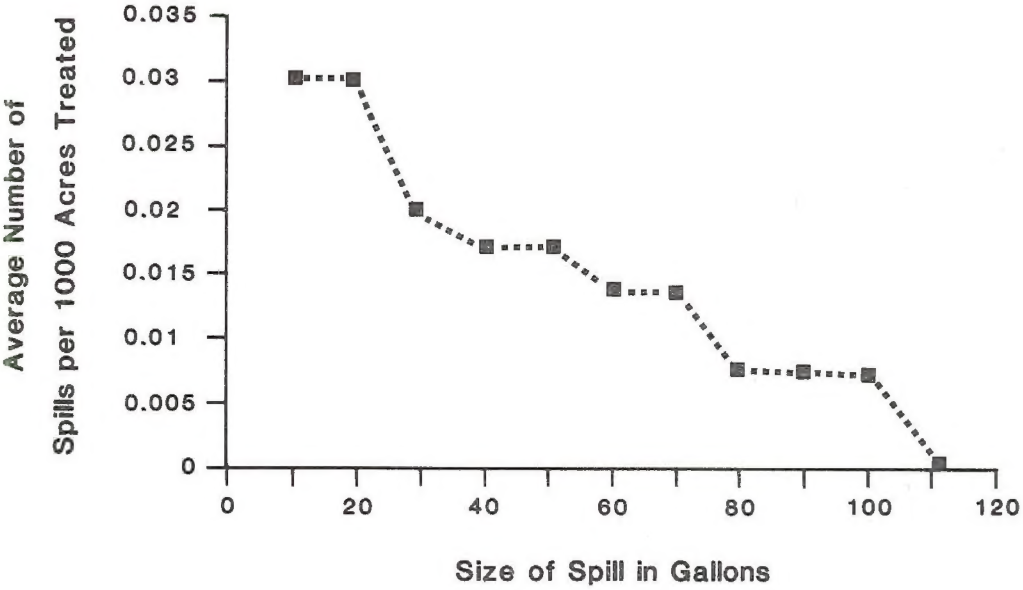


Figure H-5 Frequency and Size of Spills from Air Operations

3. It is assumed that carcinogenicity in all eight cases is not a threshold phenomenon: i.e., any dose of these chemicals has some probability of causing cancer, no matter how small the dose. This assumption is questionable for amitrole; EPA has determined that the evidence suggests a threshold phenomenon in this case.

4. The one-hit model was used to represent the relationship between dose and rate of tumor formation. This is the most conservative of several models that have been proposed because it predicts the highest cancer rates at the relatively low doses predicted for exposed humans. Other models that could have been used include the multistage, multihit, Weibull, logit, and probit models. The choice of model can affect the predicted cancer rates over several orders of magnitude. The one-hit model was used at one time by EPA, but the less conservative multistage model is now normally used. In the case of amitrole, EPA has suggested use of the even less conservative log-probit model.

5. In each case a 95-percent upper confidence limit was used to estimate cancer potency. For asulam, bromacil, 2,4-D and picloram these potencies were estimated using the maximum-likelihood procedure of the GLOBAL 82 computer program (Howe and Crump, 1982).

6. Interspecies extrapolation is a major source of uncertainty in judging cancer risk. The scaling method used in this analysis is the most conservative of the commonly accepted methods. The cancer potency of each chemical for humans was assumed to be the same as the potency for rats when scaled in terms of mg per m^2 of body surface area (mg/m^2). This method is commonly used by EPA and others, but it is not the only acceptable approach. Another equally acceptable (OSTP, 1985) method is to scale doses in terms of mg per kg of body weight (mg/kg), resulting in estimates of cancer risk that are about 16 percent of those calculated here.

7. The range of doses calculated for workers and the public in the basic scenarios covers even extreme exposures that might be encountered with each application method. Unusual exposure situations, represented by accidental spraying and large herbicide spills, have also been considered.

The probability of occurrence of cancer over a lifetime as a result of exposure to each of the chemicals was calculated using the following equations:

$$P(d) = 1 - \exp(-K \times b \times d)$$
$$d = D \times N/L$$

where:

P(d) is a conservative estimate of the probability of cancer during a person's lifetime as the result of dose d.

d is the average daily dose over a lifetime (mg/kg/day)

K is an interspecies extrapolation factor

b is a conservative estimate for cancer potency in the test animal (derived in Section 1).

The following cancer potencies (per mg/kg/day) were used: amitrole, 1.4; atrazine 3×10^{-2}; 2,4-DP, 5.9×10^{-2}; asulam, 2×10^{-2}; 2,4-D, 5.0×10^{-3}; bromacil, 3.8×10^{-3}; picloram, 5.7×10^{-4}; and glyphosate, 2.4×10^{-5}.

D is the daily dose (mg/kg/day)

N is the number of days during which the dose D occurs during an individual's lifetime

L is the number of days in a lifetime, taken to be 25,550 for a 70-year lifespan.

The interspecies extrapolation factor, K, can be estimated by assuming that body surface area is proportional to body weight to the 2/3 power (Mantel and Schneiderman, 1975), so that K would be:

$$K = (\text{human weight}/\text{test animal weight})^{1/3}$$

For an average human weight of 50 kg and an average rat weight of 350 g, K is estimated to be 5.2.

Cancer Risk to the Public

Cancer risk for the general public has been calculated for a single exposure, and also for 30 exposures over a lifetime. The approximate cancer risks to the public for the routine-realistic and routine-worst case aerial scenarios are shown in Tables H-34 and H-35. (See Attachment C for the presentation of cancer risks to the public for the other four routine exposure scenarios.) Of the three chemicals proposed for aerial application, the greatest risks are shown for atrazine. In the highest exposure situation, the large aerial scenario, the maximum risk of cancer for a single exposure is less than 1 in 10 million, for a person eating vegetables from near the spray site. Even when several routes of exposure are added for the example nearby resident, the resulting risk for a single incident is still less than 1 in 10 million. The cumulative risk due to several exposures of this magnitude would be the sum of the risks for each exposure. The risk of cancer from 30 exposures is also given in the tables, but the chance of receiving 30 exposures as large as those in the worst case is negligible. If 30 routine-worst case exposures were experienced, the cumulative risk would be less than 1 in 100,000. Exposures in the routine-realistic cases lead to much lower risk. The risk of cancer due to doses from any of the routes of exposure in the typical aerial spraying scenario is less than 1 in million, even for atrazine. Cancer risks for the other chemicals are very much less. For 2,4-D and picloram, none of the routes of exposure in any scenario results in a cancer risk greater than about 1 in 100 million, per exposure. The highest risk of

Table H-34
Lifetime Cancer Risk[a]--Exposed Public
Realistic Aerial, 40 Acres by Helicopter

Routes of Exposure	Exposures per Lifetime	Risk from Exclusive Use of:							
		2,4-D	2,4-DP	Asulam	Bromacil	Picloram	Amitrole	Glyphosate	Atrazine
For a Single Exposure									
Dermal, Spray	1	10^{-11}[b]	--[c]	--	--	10^{-14}	--	--	10^{-10}
Vegetation Contact									
Hiker	1	10^{-13}	--	--	--	10^{-16}	--	--	10^{-12}
Picker	1	10^{-9}	--	--	--	10^{-12}	--	--	10^{-8}
Drinking Water	1	10^{-9}	--	--	--	10^{-10}	--	--	10^{-8}
Eating Berries	1	10^{-9}	--	--	--	10^{-11}	--	--	10^{-8}
Eating Vegetables	1	10^{-9}	--	--	--	10^{-10}	--	--	10^{-8}
Eating Deer	1	10^{-10}	--	--	--	10^{-12}	--	--	10^{-9}
Eating Fish	1	10^{-10}	--	--	--	10^{-11}	--	--	10^{-8}
Combined Routes of Exposure									
Hiker	1	10^{-9}	--	--	--	10^{-10}	--	--	10^{-8}
Berrypicker	1	10^{-9}	--	--	--	10^{-10}	--	--	10^{-8}
Hunter	1	10^{-9}	--	--	--	10^{-10}	--	--	10^{-8}
Fisherman	1	10^{-9}	--	--	--	10^{-10}	--	--	10^{-8}
Resident	1	10^{-9}	--	--	--	10^{-10}	--	--	10^{-8}
For 30 Exposures									
Dermal, Spray	30	10^{-10}	--	--	--	10^{-12}	--	--	10^{-9}
Vegetation Contact									
Hiker	30	10^{-12}	--	--	--	10^{-14}	--	--	10^{-11}
Picker	30	10^{-8}	--	--	--	10^{-10}	--	--	10^{-6}
Drinking Water	30	10^{-8}	--	--	--	10^{-9}	--	--	10^{-7}
Eating Berries	30	10^{-8}	--	--	--	10^{-9}	--	--	10^{-7}
Eating Vegetables	30	10^{-8}	--	--	--	10^{-9}	--	--	10^{-7}
Eating Deer	30	10^{-9}	--	--	--	10^{-10}	--	--	10^{-8}
Eating Fish	30	10^{-8}	--	--	--	10^{-9}	--	--	10^{-6}
Combined Routes of Exposure									
Hiker	30	10^{-8}	--	--	--	10^{-9}	--	--	10^{-7}
Berrypicker	30	10^{-7}	--	--	--	10^{-9}	--	--	10^{-6}
Hunter	30	10^{-8}	--	--	--	10^{-9}	--	--	10^{-7}
Fisherman	30	10^{-7}	--	--	--	10^{-9}	--	--	10^{-6}
Resident	30	10^{-7}	--	--	--	10^{-9}	--	--	10^{-6}

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[a] Cancer risks shown in this Table were calculated based on a variety of assumptions that tend to overestimate risks as explained in Section 4.

[b] All of these numbers shown exponentially are to be interpreted as follows:
10^{-7} means 1 out of 10 million individuals exposed to a given herbicide via a given exposure scenario,
10^{-8} means 1 out of 100 million individuals,
10^{-9} means 1 out of 1 billion individuals, etc.

[c] Not used in aerial application.

Table H-35
Lifetime Cancer Risk[a]--Exposed Public
Large Aerial, 400 Acres by Fixed Wing, Worst Case

Routes of Exposure	Exposures per Lifetime	Risk from Exclusive Use of:							
		2,4-D	2,4-DP	Asulam	Bromacil	Picloram	Amitrole	Glyphosate	Atrazine
For a Single Exposure									
Dermal, Spray	1	10^{-8}[b]	--[c]	--	--	10^{-10}	--	--	10^{-7}
Vegetation Contact									
Hiker	1	10^{-10}	--	--	--	10^{-12}	--	--	10^{-9}
Picker	1	10^{-8}	--	--	--	10^{-10}	--	--	10^{-7}
Drinking Water	1	10^{-8}	--	--	--	10^{-9}	--	--	10^{-8}
Eating Berries	1	10^{-8}	--	--	--	10^{-9}	--	--	10^{-8}
Eating Vegetables	1	10^{-8}	--	--	--	10^{-9}	--	--	10^{-7}
Eating Deer	1	10^{-9}	--	--	--	10^{-10}	--	--	10^{-9}
Eating Fish	1	10^{-9}	--	--	--	10^{-10}	--	--	10^{-7}
Combined Routes of Exposure									
Hiker	1	10^{-8}	--	--	--	10^{-9}	--	--	10^{-7}
Berrypicker	1	10^{-8}	--	--	--	10^{-9}	--	--	10^{-7}
Hunter	1	10^{-8}	--	--	--	10^{-9}	--	--	10^{-7}
Fisherman	1	10^{-8}	--	--	--	10^{-9}	--	--	10^{-7}
Resident	1	10^{-8}	--	--	--	10^{-9}	--	--	10^{-7}
For 30 Exposures									
Dermal, Spray	30	10^{-7}	--	--	--	10^{-9}	--	--	10^{-6}
Vegetation Contact									
Hiker	30	10^{-9}	--	--	--	10^{-11}	--	--	10^{-8}
Picker	30	10^{-7}	--	--	--	10^{-9}	--	--	10^{-6}
Drinking Water	30	10^{-7}	--	--	--	10^{-8}	--	--	10^{-6}
Eating Berries	30	10^{-7}	--	--	--	10^{-8}	--	--	10^{-6}
Eating Vegetables	30	10^{-7}	--	--	--	10^{-8}	--	--	10^{-6}
Eating Deer	30	10^{-8}	--	--	--	10^{-9}	--	--	10^{-7}
Eating Fish	30	10^{-7}	--	--	--	10^{-8}	--	--	10^{-6}
Combined Routes of Exposure									
Hiker	30	10^{-7}	--	--	--	10^{-8}	--	--	10^{-6}
Berrypicker	30	10^{-6}	--	--	--	10^{-7}	--	--	10^{-5}
Hunter	30	10^{-7}	--	--	--	10^{-8}	--	--	10^{-6}
Fisherman	30	10^{-7}	--	--	--	10^{-8}	--	--	10^{-5}
Resident	30	10^{-6}	--	--	--	10^{-7}	--	--	10^{-6}

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[a] Cancer risks shown in this Table were calculated based on a variety of assumptions that tend to overestimate risks as explained in Section 4.

[b] All of these numbers shown exponentially are to be interpreted as follows:

10^{-7} means 1 out of 10 million individuals exposed to a given herbicide via a given exposure scenario,
10^{-8} means 1 out of 100 million individuals,
10^{-9} means 1 out of 1 billion individuals, etc.

[c] Not used in aerial application.

cancer to the public from the other five cancer-causing herbicides is from backpack spraying large areas. The highest risk due to any routes of exposure is less than 2 in 100,000 for amitrole (Table C-140).

Cancer Risk to Workers

Cancer risk to workers has been calculated for an expected case assuming 5 years of employment in herbicide application, and an average number of days of spraying per year. The average number of exposures per lifetime was estimated to range from 30 to 70. The risk has been calculated in the extreme cases assuming 30 years of employment and a total of 288 to 480 exposures. It is very unlikely that a worker would apply herbicides on the number of days assumed in the worst case. The lifetime cancer risks for workers are shown in Table H-36. (Cancer risk to workers for the accidental-worst case scenario is shown in Attachment C.) The risks for each herbicide were calculated assuming that only that herbicide was used. The highest risks for workers involve 2,4-DP and atrazine use. The lifetime cancer risk to a backpack sprayer using only 2,4-DP or atrazine is about 1 in 10,000 in the expected case. In the worst case the risk is greater than 1 in 1,000. The risk is much less for the other chemicals. The highest risk for 2,4-D is about 1 in 100,000 for backpack spraying in the expected case, and in the extreme case the greatest risk is about 1 in 10,000. The risk is somewhat greater for amitrole: as high as 7 in 100,000 for the realistic backpack exposure. Workers using asulam and bromacil in the extreme case have a lifetime cancer risk of less than 6 in 100,000 in all worker categories. The cancer risk from picloram or glyphosate use is even less for all worker categories. The risk in the expected case never exceeds 3 in 10 million.

EPA (1985a) has also conducted a carcinogenic risk assessment for workers using amitrole (see Table H-37). EPA assumed that workers wore no protective clothing, and the estimated exposures were only 1.5×10^{-3} mg/kg/day for the highest exposures. EPA estimated cancer potency for both liver and thyroid tumors, using the log-probit and multistage models. Estimated cancer risks for the anti-thyroid action of amitrole were all less than 1 in 10 billion based on the log-probit model. The multistage model gave much higher risk estimates, especially for liver tumors. Calculated risks for average worker exposures were not greater than 1 in 10,000, and for maximum exposures the risks were not greater than 1 in 1,000. Amitrole carcinogenicity risks calculated in this risk assessment are consistent with EPA's independently derived results.

Cancer Risks in Accidental Situations

Cancer risks calculated for exposures due to accidental spraying are shown in Attachment C (Table C-144). The greatest risks among the seven chemicals are for amitrole. A single incident of accidental spraying of amitrole gives calculated risks of 6 in 100,000 for a person eating sprayed vegetables and 3 in 100,000 for a person drinking sprayed water. Among the other chemicals, the greatest risks are about 4 in 1 million for exposures to 2,4-DP, and 3 in 10 million for 2,4-D. Multiple incidents could be expected to result in cumulative risks. Cancer risks calculated for spill situations are also shown in Attachment C. The greatest risks are for spills of herbicide concentrate directly onto clothing and skin.

Table H-36
Lifetime Cancer Risk[a]--Exposed Workers

Routes of Exposure	Exposures per Lifetime	Risk from Exclusive Use of:							
		2,4-D	2,4-DP	Asulam	Bromacil	Picloram	Amitrole	Glyphosate	Atrazine
For Realistic Number of Exposures									
Pilot	30	10^{-6}[b]	--[c]	--	--	10^{-8}	--	--	10^{-5}
Mixer-Loader	30	10^{-6}	--	--	--	10^{-8}	--	--	10^{-5}
Supervisor	30	10^{-7}	--	--	--	10^{-9}	--	--	10^{-6}
Observer	30	10^{-8}	--	--	--	10^{-10}	--	--	10^{-7}
Backpack	50	10^{-5}	10^{-4}	10^{-6}	10^{-6}	10^{-8}	10^{-5}	10^{-7}	10^{-4}
R-O-W Sprayer	45	10^{-7}	10^{-6}	10^{-7}	10^{-7}	10^{-9}	10^{-6}	10^{-8}	10^{-6}
R-O-W Mix/L	45	10^{-7}	10^{-6}	10^{-7}	10^{-7}	10^{-9}	10^{-6}	10^{-9}	10^{-6}
R-O-W AP/M/L	45	10^{-7}	10^{-6}	10^{-7}	10^{-7}	10^{-9}	10^{-6}	10^{-9}	10^{-6}
Hack and Squirt	70	10^{-6}	10^{-4}	--	10^{-6}	10^{-8}	10^{-5}	--	--
Injection Bar	70	10^{-6}	10^{-5}	--	10^{-7}	10^{-8}	10^{-6}	--	--
Worst Case Number of Exposures									
Pilot	288	10^{-5}	--	--	--	10^{-8}	--	--	10^{-4}
Mixer-Loader	288	10^{-5}	--	--	--	10^{-7}	--	--	10^{-4}
Supervisor	288	10^{-6}	--	--	--	10^{-8}	--	--	10^{-5}
Observer	288	10^{-7}	--	--	--	10^{-9}	--	--	10^{-6}
Backpack	440	10^{-4}	10^{-3}	10^{-5}	10^{-5}	10^{-7}	10^{-4}	10^{-6}	10^{-3}
R-O-W Sprayer	416	10^{-6}	10^{-5}	10^{-6}	10^{-6}	10^{-8}	10^{-5}	10^{-8}	10^{-5}
R-O-W Mix/L	416	10^{-6}	10^{-5}	10^{-6}	10^{-6}	10^{-8}	10^{-5}	10^{-8}	10^{-5}
R-O-W AP/M/L	416	10^{-6}	10^{-5}	10^{-6}	10^{-6}	10^{-8}	10^{-5}	10^{-8}	10^{-5}
Hack and Squirt	480	10^{-5}	10^{-4}	--	10^{-5}	10^{-7}	10^{-4}	--	--
Injection Bar	480	10^{-5}	10^{-4}	--	10^{-6}	10^{-8}	10^{-5}	--	--

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[a] Cancer risks shown in this Table were calculated based on a variety of assumptions that tend to overestimate risks as explained in Section 4.

[b] All of these numbers shown exponentially are to be interpreted as follows:
10^{-7} means 1 out of 10 million individuals exposed to a given herbicide via a given exposure scenario,
10^{-8} means 1 out of 100 million individuals,
10^{-9} means 1 out of 1 billion individuals, etc.

[c] Not used in this application.

Table H-37
Amitrole Worker Exposure Estimates and Related Estimates of Cancer Risk

Exposure Situation[a]	Exposure (mg/kg/day)	Log-Probit[b]	Upper 95% Bound on Risk Multi-Stage	
			$Q_{1e}^* = .20$[c]	$Q_{1u}^* = .076$[d]
Utility Power Wagon Mixer-Loader/Applicator				
Minimum	$1.1\text{x}10^{-4}$[e]	10^{-10}	10^{-5}	10^{-5}
Average	$4.6\text{x}10^{-4}$	10^{-10}	10^{-4}	$10^{-5} - 10^{-4}$
Maximum	$1.2\text{x}10^{-3}$	10^{-10}	10^{-4}	10^{-4}
Industry Power Wagon Mixer-Loader/Applicator				
Minimum	$6.3\text{x}10^{-5}$	10^{-10}	10^{-51}	$10^{-6} - 10^{-5}$
Average	$4.3\text{x}10^{-4}$	10^{-10}	10^{-4}	$10^{-5} - 10^{-4}$
Maximum	$1.1\text{x}10^{-3}$	10^{-10}	10^{-4}	10^{-4}
Industry Knapsack/ Hand Carry Applicator				
Minimum	$4.9\text{x}10^{-6}$	10^{-10}	10^{-6}	$10^{-7} - 10^{-6}$
Average	$3.7\text{x}10^{-4}$	10^{-10}	$10^{-5} - 10^{-4}$	10^{-5}
Maximum	$1.5\text{x}10^{-3}$	10^{-10}	$10^{-4} - 10^{-3}$	10^{-4}
Industry Knapsack/ Hand Carry/Mixer-Loader				
Minimum	$5.3\text{x}10^{-7}$	10^{-10}	10^{-7}	$10^{-8} - 10^{-7}$
Average	$2.7\text{x}10^{-5}$	10^{-10}	$10^{-6} - 10^{-5}$	10^{-6}
Maximum	$1.3\text{x}10^{-4}$	10^{-10}	10^{-5}	10^{-5}

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[a] Exposure estimates of dermal exposure and inhalation exposure were taken from Hitch memo of 12/15/83 adjusted for a maximum of 0.1 percent dermal penetration. Zendzian memo of 6/26/85, annual exposure estimate is divided by 70 kg to obtain exposure in mg/kg and by 365 and 2 to obtain average daily dose for one-half of a 70-year lifetime.

[b] Log-Probit: This column represents the risks bounds under the assumption of the anti-thyroid action of amitrole.

[c] Q_{1e}^*: This column represents the risk bounds under the assumption of the interspecies surface area correction; and based on liver tumors in female mice.

[d] Q_{1u}^*: This column represents the risk bounds without the interspecies surface area correction; and based on thyroid tumors in male rats.

[e] Cancer risk shown in this Table were calculated based on a variety of assumptions that tend to overestimate risks as explained in Section 4.

Workers are at the greatest risk for this type of accident. The tabled values assume that most of a person's skin has been contacted by the solution, and cleanup does not occur for several hours. This is certainly contrary to standard practice. A spill of 2,4-DP concentrate onto a person gives a risk of about 3 in 1,000, and a spill of spray mixture gives a lesser risk of about 1 in 10,000. The corresponding risks for 2,4-D and amitrole are about a factor of 10 less. The risk of cancer due to spills of asulam and bromacil is about 1 in 100,000 for the concentrate and 1 in 1 million for the spray mixture. A spill of picloram or glyphosate concentrate gives a risk of 2 in 1 million or less. Cancer risks arising from even major spills into drinking water supplies are significantly less. A 100-gallon helicopter load of 2,4-D spray mixture dumped into a 1-acre pond would lead to a risk of cancer of not more than 8 in 100 million for a person drinking a liter of the water. The corresponding risks for the other chemicals are less. If a 1,000-gallon tank truck of spray mixture were spilled into a small pond, the risk for amitrole would be about 4 in 10,000. For 2,4-D the corresponding cancer risk is less than 1 in 1 million.

Comparison of Cancer Risks with Other Common Risks

To put the cancer risks calculated here in perspective, Table H-38 lists risks due to some more familiar hazards and occupational risks. Motor vehicle accidents have a risk of fatality that averages 2 in 10,000 per person each year. Over a 30-year period, the cumulative risk would be 6 in 1,000. A variety of hazards are listed in the table that have a risk of about 1 in 1 million. They include smoking 2 cigarettes, eating 6 pounds of peanut butter, drinking 40 sodas sweetened with saccharin, or taking one transcontinental round trip by air. The cancer risk for a single X-ray is 7 in 1 million. Many occupational risks are greater. Working for 30 years in agriculture or construction has a risk of about 1.8 in 100, and in mining and quarrying the risk is even greater: 3 in 100 over 30 years.

RISK OF HERITABLE MUTATIONS

No human studies are available that associate any of the herbicides with heritable mutations. Furthermore, no risk assessments that quantify the probability of mutations are available in the literature or from EPA. Laboratory studies constitute the best available information on mutagenic potential. Results of the mutagenicity assays conducted on the 16 herbicides are summarized in Table H-4.

For some of the herbicides, no validated mutagenicity tests exist or the mutagenicity tests conducted are insufficient to conclude whether the chemical is mutagenic. For these herbicides, a worst case assumption is made that these herbicides have the potential to cause mutations in humans. In these cases the results of carcinogenicity tests (see Table H-4) or cancer risk assessments can be used to estimate the risk of heritable mutations. The rationale for this assumption is summarized by the USDA (1985) as follows: "Since mutagenicity and carcinogenicity both follow similar mechanistic steps (at least those that involve genetic toxicity), the increased risk of cancer can be used to approximate the

Table H-38
Lifetime Risk of Death or Cancer Resulting from Everyday Activities

Activity	Need to Accumulate a One in a Million Risk of Death	Average Annual Risk[a] per Capita
Based on living in the United States		
Motor vehicle accident	1.5 days	2×10^{-4}[b,c]
Falls	6 days	6×10^{-5}
Drowning	10 days	4×10^{-5}
Fires	13 days	3×10^{-5}
Firearms	36 days	1×10^{-5}
Electrocution	2 months	5×10^{-6}
Tornados	20 months	6×10^{-7}
Floods	20 months	6×10^{-7}
Lightning	2 years	5×10^{-7}
Animal bite or sting	4 years	2×10^{-7}
Occupational Risks		
General		
manufacturing	4.5 days	8×10^{-5}
trade	7 days	5×10^{-5}
service and government	3.5 days	1×10^{-4}
transport and public utilities	1 day	4×10^{-4}
agriculture	15 hours	6×10^{-4}
construction	14 hours	6×10^{-14}
mining and quarrying	9 hours	1×10^{-3}
Specific		
coal mining (accidents)	14 hours	6×10^{-4}
police duty	1.5 days	2×10^{-4}
railroad employment	1.5 days	2×10^{-4}
fire fighting	11 days	8×10^{-4}
Everyday Risks		
Eating and drinking	40 diet sodas (saccharin)	
	6 pounds of peanut butter (aflatoxin)	
	180 pints of milk (aflatoxin)	
	200 gallons of drinking water from Miami or New Orleans	
	90 pounds of broiled steak (cancer risk only)	
Smoking	2 cigarettes	

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[a] Note to calculate the risk over a lifetime multiply this column by 70. From Crouch and Wilson (1982).

[b] Cancer risks shown in this Table were calculated based on a variety of assumptions that tend to overestimate risk as explained in Section 4.

[c] All of these numbers shown exponentially are to be interpreted as follows:

10^{-7} means 1 out of 10 million individuals exposed to a given herbicide via a given exposure scenario,
10^{-8} means 1 out of 100 million individuals,
10^{-9} means 1 out of 1 billion individuals.

quantitative risk of heritable mutations. The basis for this assumption is that both mutagenicity and at least primary carcinogens react with DNA to form a mutation or DNA lesion affecting a particular gene or set of genes. The genetic lesions then require specific metabolic processes to occur, or the cells must divide to insert the lesion into the genetic code of the cell. We believe the cancer risk provides a worst-case approximation to heritable mutations because cancer involves many types of cells whereas heritable mutations involve only germinal (reproductive) cells."

Asulam and glyphosate tested negative for mutagenicity in all assays conducted, and thus can be considered to pose no mutagenic risk.

Fosamine, hexazinone, simazine, and triclopyr were nonmutagenic in the great majority of assays conducted and were nononcogenic in all of the carcinogenicity tests performed; therefore, it can be assumed that their mutagenic risk is slight to negligible. Dicamba was nonmutagenic in most of the assays performed and no oncogenicity was found in several long-term studies. EPA (1985d) has classified the chronic studies as "inadequate to evaluate the oncogenic potential of dicamba." Due to the bulk of negative results, dicamba can be considered as a mutagen in the worst-case analysis but the mutagenic hazard would be extremely limited.

No validated mutagenicity studies have been conducted with dalapon, or diuron. The worst-case assumption is that all of these chemicals are mutagenic. The probability of dalapon or diuron causing heritable mutations is low because they have not been shown to cause cancer in any long-term studies.

The negative oncogenic studies for diuron were classified by EPA (1985d) as inadequate to determine carcinogenic potential to mammalian organisms. The lack of positive results in mutagenic or oncogenic tests with diuron suggests that diuron would present a very low risk to humans as a mutagen.

Bromacil tested positive in one of two oncogenic studies. The risk of heritable mutations from the chemical should be no greater than the estimates of cancer risk based on a worst-case approximation.

Atrazine tested positive for mutagenicity in 15 of 33 assays. The worst-case assumption is that atrazine is mutagenic. However, many of the positive results were achieved through tests that may not be relevant to evaluating mutagenic risk in humans. Some positive results in rodents were also achieved, but these in vivo responses were only observed at levels greater than 1,500 mg/kg body weight. These are exceptionally high levels and suggest that the degree of germ cell hazard from low levels of atrazine would be minimal. The worst-case estimate for atrazine mutagenic effects would be the risk of cancer as shown in Tables H-34 through H-36.

Amitrole was nonmutagenic in 56 microbial gene mutation tests. The results of two tests which were positive are considered of questionable validity by EPA (1985a), and overall it is considered to pose no potential for heritable mutations (EPA, 1985a). The worst-case estimate for amitrole mutagenic effects would be the risk of cancer as shown in Tables H-34 and H-35.

For picloram and 2,4-D, there have been only a few studies performed and these have indicated both positive and negative mutagenic potential. EPA has requested more mutagenicity-test information for both of these compounds. A number of comprehensive reviews of the 2,4-D mutagenic data have indicated that it does not pose significant risk of human gene mutations (USDA, 1984). 2,4-D has been shown to be nononcogenic in the two carcinogenicity studies that have been conducted. Based on a worst-case estimate, the risk of heritable mutations from these chemicals would be no greater than the estimates of cancer risk.

Mutagenic tests with 2,4-DP have shown mixed results. 2,4-DP was negative in four microbial assays and positive in four other assays; therefore it may have limited genotoxic potential. Based on the limited test data presented in Section 2, one cannot presume mutagenic hazard because no in vivo or mammalian assays have been conducted. However, the worst-case assumption is that 2,4-DP is mutagenic and the mutagenic risk in the worst case would be no greater than the risk of cancer.

SYNERGISTIC AND CUMULATIVE EFFECTS

Synergistic Effects

Synergistic effects of herbicides are those that occur because of simultaneous exposure to more than one herbicide and that cannot be predicted based on the effects of the individual chemicals. A synergistic effect occurs when the combined effect of two chemicals is much greater than the sum of the effects of each agent given alone. Based on the limited amount of data available on pesticide combinations, it is possible but very unlikely that synergistic effects could occur as a result of exposure to two or more of the herbicides considered in this analysis.

The effects of many of the possible herbicide combinations have not been studied. This is not surprising because the first priority must be to study the effects of the herbicides individually, and this type of information is not yet sufficient in some cases. Moreover, the combinations that could be studied are too numerous to be listed. The combinations of interest include not only combinations of 2 or more of the 16 herbicides, but also combinations of the herbicides with other chemicals, such as insecticides, that exist in the environment.

However, Kociba and Mullison (1985) in describing toxicological interactions with agricultural chemicals state:

> Our present scientific knowledge in toxicology indicates that an exposure to a mixture of pesticides is more likely to lead to additivity or antagonism rather than synergism when considering the toxicological effects of such a combination. To be conservative and for reasons of safety, an additive type of toxicological response is generally assumed rather than an antagonistic type of response.

> In the case of registered pesticides, a great amount of toxicological information is developed during the research and development of each individual pesticide. In addition to this information on individual pesticides, short-term toxicity studies are always done prior to the selling of a pesticide mixture. Should synergism unexpectedly be present in a proposed commercial mixture of two pesticides, it would be identified in such cases and would then be dealt with accordingly. In toxicological tests involving a combination of commercial pesticides, synergism has generally not been observed.

Kociba and Mullison (1985) use a specific example of a mixture of 2,4-D and picloram to illustrate their point. They list the LD_{50}s of each herbicide separately and the LD_{50} of the mixture. The mixture LD_{50} is between the LD_{50}s of the two constituents indicating lack of a synergistic effect.

The possibility of synergistic effects can be examined for the 16 herbicides addressed in this analysis in the same way (see Table H-39). Based on a review of oral acute LD_{50}s for mixtures of 2 or more of the 16 herbicides used in this analysis that have been submitted to EPA, no synergistic effects were found. In no case is the mixture of two herbicides more acutely toxic than any of the constituents. For example, a mixture of 2,4-D and Banvel 45 (dicamba) formulation resulted in a NOEL of 1,847 mg/kg, with lower acute LD_{50} values reported for the technical grade of both formulation constituents (EPA, 1984e). Rat inhalation studies of formulations containing 2,4-D and picloram did not result in toxic effects (EPA, 1984q). This gives at least a first indication that synergistic effects are unlikely to occur in the vegetation management program.

One synergistic effect documented in the literature is the combination of 2,4-D and picloram produces skin sensitization, while neither alone produces this effect (EPA, 1984q). Moreover, it is highly unlikely that synergistic adverse effects could result from exposure to more than one herbicide applied in separate projects. There are several reasons for this. First, unlike the situation in conventional agriculture, herbicide residues in plants and soil are not expected to persist from one application to another, even for the more persistent herbicides. Silvicultural and range applications are not annual; there are typically many years between applications.

Second, none of the 16 herbicides accumulates in human tissues, so exposure of an individual to 2 herbicides at different times would be unlikely to cause simultaneous residues within the body.

Third, exposures to the herbicides, especially for the public, are normally quite small. The greater exposures considered in the routine-worst case scenarios would occur only very infrequently, and the probability of the accidental exposures is extremely low. Because the probability of a large exposure is small for any one chemical, the probability of large exposures simultaneously to multiple chemicals is negligible. This is because the probability of two independent events occurring simultaneously is the

Table H-39.
Acute LD_{50}'s of Herbicide Mixtures Compared to Acute LD_{50}s of Individual Herbicides

Combination	Test	Level in Comp. 1	Level in Comp. 2	Level in Comp. 3	Level in Comp. 4
Banvel 4 Atrazine 80 WP Princip. WP Paraquat 2EC	Acute Dermal LD_{50} rabbit (level not given) LD_{50} 20,000 mg/kg	Banvel 4 (Dicamba) rabbit (level not given) LD_{50} 2,000 mg/kg Tech., DMA Salt	Atrazine 80 WP (level not given) LD_{50} 7,000 kg/mg Tech., rabbit	Princip WP Simazine (level not given) BOW formulation rabbit	Paraquat 2EC (level not given) LD_{50} 24 mg/kg (W.S.S.A)
Banvel 4 Atrazine 80 WP Princip. WP Paraquat 2EC	Acute Oral rat (level not given) LD_{50} 5,000 mg/kg	Banvel 4 LD_{50} 757 mg/kg	Atrazine 80 WP LD_{50} 1,869 kg/mg	Princip. WP (Simazine) LD_{50} 5,000 kg/mg	Paraquat 2EC LD_{50} 120 mg/kg (W.S.S.A)
2,4-D MCPA Dicamba	Acute Oral rat LD_{50} 5,000 mg/kg	2,4-D 71.42% 532 mg/kg	MCPA .71% 800 kg/mg	Dicamba .04% 757 kg/mg rat	
2,4-D MCPA Dicamba	Acute Dermal rabbit LD_{50} 2,000 mg/kg	2,4-D 1,400 mg/kg (DOE 1983)	MCPA	Dicamba LD_{50} 2,000 mg/kg	
2,4-D and Banvel 45 (Dicamba) Levels not given	Acute Oral rat LD_{50} 1,847 mg/kg	2,4-D LD_{50} 532 mg/kg	Banvel 45 LD_{50} 757 mg/kg		
2,4-D and Banvel 45 (Dicamba) Levels not given	Acute Dermal rabbit LD_{50} 11,892 mg/kg	2,4-D LD_{50} 400 mg/kg (DOE 1983)	Banvel 45 LD_{50} 2,000 mg/kg		
2,4-D 1.15% Dicamba 1.60% MCPP 1.06%	Acute Oral 10 LD_{50} 20 gm slight erytherae edema	2,4-D 1.15% LD_{50} 532 mg/kg 532 mg/kg	Dicamba 1.60% LD_{50} 757 mg/kg 800 kg/mg	MCPP 1.06% (mecoprop) 1,060 mg/kg W.S.S.A.	

Table H-39 (continued).

Combination	Test	Level in Comp. 1	Level in Comp. 2	Level in Comp. 3	Level in Comp. 4
2,4-D .99% MCPP .99%	Acute Dermal LD$_{50}$ 2,000 mg/kg	2,4-D .99% LD$_{50}$ 1,400 mg/kg (DOE 1983)	MCPP .99% LD$_{50}$ 900 mg/kg (W.S.S.A.)		
2,4-D .5820% MCPP .2448% Dicamba .0516%	Acute Oral LD$_{50}$ 5,050 mg/kg	2,4-D .582% LD$_{50}$ 532 mg/kg	MCPP .2448% LD$_{50}$ 1,060 mg/kg (W.S.S.A.)	Dicamba .0516% LD$_{50}$ 757 mg/kg	
Banvel 45 + Lasso 4EC (Alachlor) % comp. not given	Acute Oral LD$_{50}$ 5,000 mg/kg	Banvel 45 LD$_{50}$ 757 mg/kg	Lasso 4EC (Alachlor) 1,000 mg/kg (W.S.S.A.)		
Banvel 45 + Lasso 4EC (Alachlor) % comp. not given	Acute Dermal LD$_{50}$ 20,000 mg/kg	Banvel 45 (Dicamba) LD$_{50}$ 2,000 mg/kg	Lasso 4EC (Alachlor) 13,300 mg/kg (W.S.S.A.)		
2,4-D 1.455% MCPA .612% Dicamba .129%	Acute Dermal, rabbit LD$_{50}$ 2,005 mg/kg	2,4-D 1.455% LD$_{50}$ 1,400 mg/kg (DOE 1983)	MCPA .612%	Dicamba .129% LD$_{50}$ 2,000 mg/kg	
2,4-D .680% MCPP .680% Dicamba .027%	Acute Oral LD$_{50}$ 5,000 mg/kg	2,4-D .680% LD$_{50}$ 532 mg/kg	MCPP .680% LD$_{50}$ 1,060 mg/kg (WSSA 1983)	Dicamba .027% LD$_{50}$ 757 mg/kg	
2,4-D .680% MCPP .680% Dicamba .027%	Acute Dermal LD$_{50}$ 2,000 mg/kg	2,4-D .680% LD$_{50}$ 1,400 mg/kg (DOE 1983)	MCPP .680% LD$_{50}$ 900 mg/kg (WSSA 1983)	Dicamba .027% LD$_{50}$ 2,000 mg/kg	
2,4-D 1.37% MCPP 1.37% Dicamba .055%	Acute Oral LD$_{50}$ 5,000 mg/kg	2,4-D 1.37% LD$_{50}$ 532 mg/kg	MCPP 1.37% LD$_{50}$ 1,060 mg/kg (WSSA 1983)	Dicamba .055% LD$_{50}$ 2,000 mg/kg	
2,4-D 1.370% MCPP 1.37% Dicamba .055%	Acute Dermal, rabbit LD$_{50}$ 2,000 mg/kg	2,4-D 1.37% LD$_{50}$ 1,400 mg/kg (DOE 1983)	MCPP 1.37% LD$_{50}$ 900 mg/kg (WSSA 1983)	Dicamba .055% LD$_{50}$ 2,000 mg/kg	

Table H-39 (continued).

Combination	Test	Level in Comp. 1	Level in Comp. 2	Level in Comp. 3	Level in Comp. 4
2,4-D .58% MCPP .58%	Acute Oral, rat LD_{50} 5,000 mg/kg	2,4-D .58% LD_{50} 532 mg/kg	MCPP .58% LD_{50} 1,060 mg/kg (WSSA 1983)		
2,4-D .58% MCPP .58%	Acute Dermal, rabbit LD_{50} 2,000 mg/kg	2,4-D .58% LD_{50} 1,400 mg/kg (DOE 1983)	MCPP .58% LD_{50} 900 mg/kg (WSSA 1983)		
2,4-D .99% MCPP .99%	Acute Oral LD_{50} 5,000 mg/kg	2,4-D .99% LD_{50} 532 mg/kg	MCPP .99% LD_{50} 1,060 mg/kg (WSSA 1983)		
2,4-D 46.7% 2,4-DP 45.9%	Acute Oral LD_{50} 887 mg/kg	2,4-D 46.7% LD_{50} 532 mg/kg	2,4-DP 45.9% LD_{50} 532 mg/kg		
2,4-D 46.7% 2,4-DP 45.9%	Acute Dermal LD_{50} 2,405 mg/kg	2,4-D 46.7% LD_{50} 1,400 mg/kg (DOE 1983)	2,4-DP 45.9% LD_{50} 2,000 mg/kg		
Dicloram 17.1% Triclopyr 32.5%	Acute Oral LD_{50} 2,991 mg/kg$^{(m)}$ 3,011 mg/kg$^{(f)}$	Dicloram 17.1% LD_{50} 8,200 mg/kg	Triclopyr 32.5% LD_{50} 630-739 mg/kg		
Dicloram 17.1% Triclopyr 32.5T	Acute Dermal LD_{50} 1,485 mg/kg	Dicloram 17.1% LD_{50} 4,000 mg/kg	Triclopyr 32.5% LD_{50} 2,000 mg/kg		
Simazine, same status listed under dicamba princep WP. acute dermal and acute oral					

product of the probabilities of the individual events. For example, if the probability of a person receiving a given exposure is 1 in 1,000 for 2 herbicides, then the probability of receiving that exposure to both herbicides would be 1 in 1 million.

Simultaneous exposure to more than one chemical is likely in cases where those chemicals are combined in a single spray mixture. Although the great majority of vegetation control projects in California involve only a single herbicide, a number of acres are treated with mixtures of herbicides. However, the only herbicide mixtures used are combinations that have been approved for use by the Environmental Protection Agency.

Cumulative Effects

The total area of BLM land covered by this EIS is 18.5 million acres. This area makes up less than one-fifth of the total land area in the California and northwest Nevada geographic area. In a given year, the BLM may treat up to 6,900 acres with herbicides for vegetation management. The treated area would thus comprise four ten-thousandths (less than 0.04 percent) of the total land area of the two States. Moreover, the treatments would occur for the most part in the remote areas of these either densely forested or range lands. In general, treatment units are sprayed only once in a given year, then not treated again until a number of years later. The later treatment also may be with a different herbicide.

No one individual member of the public is likely to receive repeated exposures to any of the herbicides because of the remoteness of most treatment units, the widely spaced timing of repeated treatments, and the use of a variety of herbicides for different purposes. In addition, the precautions taken by the BLM in their treatment operations make any dose at all to the public quite unlikely. This risk assessment used the lowest NOELs found in chronic animal laboratory studies for comparison with estimated human doses. The risk analysis results showed that, except for amitrole and triclopyr, margins of safety for the public from realistic treatment scenarios are greater than 200. Thus, members of the public could receive doses of these herbicides repeatedly over the years, even though the chance of receiving multiple doses is negligible, and still not suffer toxic effects. Some individuals who may be particularly sensitive to amitrole or triclopyr may experience ill effects but, again, this should occur only in the unusual circumstance of repeated doses. The public an be exposed to a wide variety of other chemical compounds through both voluntary and involuntary routes of exposure. BLM acknowledges that the potentially exposed public from proposed vegetation management programs do not live in a chemical free environment. However,, because of the reasons stated above additional risk to humans from BLM operations from year to year would be insignificant. Sensitive individuals are discussed in the next section.

Cumulative effects on workers have been considered throughout this analysis. The risk of workers experiencing toxic effects, including cancer, assumes that they are chronically exposed to these herbicides. Backpack applicators are at greatest risk from cumulative effects. Contract employees are not expected to be at any greater risk than government employees.

Factors Affecting the Sensitivity of Individuals

Individuals typically display a range of susceptibilities to toxic effects of chemicals. Factors that may affect susceptibility include diet, age, heredity, preexisting diseases, and lifestyle (Calabrese 1978). These factors have been studied in detail for very few cases, and their significance in controlling toxicity of the proposed herbicides is not known. However, enough data has been collected on other chemicals to show that these factors can be important.

Populations at Risk

The populations at risk in herbicide spraying operations fall into three categories: (1) workers involved in the spray operations, (2) public land users such as hikers, hunters, and fishermen, and (3) residents of dwellings in and near the public lands.

The number of workers involved in spraying operations for a typical spray year for the BLM is likely to not exceed 25. The number of visitors to BLM land is recorded as visitor days by the agency. Total visits to BLM public lands averages about 29 million annually in California.

Because of the remote locations of most herbicide application sites, no member of the public should be exposed in the vast majority of operations. Silvicultural operations present the least probability of exposure, while right-of-way and facilities maintenance operations present the greatest probability of exposure.

The only possibility for exposure beyond one-half mile distance is in the extremely unlikely event of an accidental worst-case spill.

ATTACHMENT A

DETAILS OF MUTAGENICITY AND CARCINOGENICITY TESTING

MUTAGENICITY

This subsection presents the details of mutagenicity tests conducted on amitrole, atrazine, bromacil, 2,4-DP, and dicamba.

Amitrole

The mutagenic potential of amitrole is summarized by the following information from EPA (1985a):

> Amitrole has been evaluated in a variety of mutagenicity test systems. Although positive results were reported by Braun et al., 1977, (using added nitrite) in *Salmonella* and by Venitt and Crofton-Sleigh (1981) in *Salmonella* and *E. coli*, 49 other *Salmonella* gene mutation tests and 9 other *E. coli* tests were negative. The validity of the two positive studies is questionable. The weakly positive results by Carere et al. (1976, 1978, and 1981) were in an unvalidated system using unusual bacteria. The mechanisms for these positive results reported for the DNA repair assays cannot be determined without positive gene mutation or chromosome aberration assays. The negative results in the sister chromatid exchange assay in mammalian cells in culture (which is a very sensitive assay) and the chromosome aberration assays in cultured human lymphocytes or in vivo mouse bone marrow cells cast doubt on the significance of the DNA repair assays. Amitrole does not present a potential for heritable genetic effects.
>
> Amitrole is able to induce transformation of cultured cells. It was positive in four in vitro transformation studies using rat and hamster cells (Pienta, 1977; Inoue, 1981; Dunkel, 1981; Styles, 1981) following treatment of 0.1 to 100 ug/ml. This test is used to establish the malignant activities of test compounds on mammalian cells in vitro. Cells treated in vitro with chemical carcinogens give rise to foci of cellular growth superimposed on the cell monolayer. If these foci are picked from the cultures, grown to larger numbers, and injected into animals, a malignant tumor will be obtained, in most cases. Therefore, the appearance of piled-up colonies in treated cell cultures is correlated with malignant transformation. In addition, weak cellular transformation capacity was observed in EUE cells (no data presented, only summary) (Benigni, 1980).
>
> These transformation assays are not able to determine a mechanism for tumor formation and do not necessarily show that a transformation inducer is genotoxic. These results support oncogenicity potential but not necessarily mutagenicity potential.

Atrazine

Atrazine did not induce mutations in microbial assay systems evaluated by EPA (1984c). All of the following positive results were reported in USDA (1984). Atrazine represents an unusual situation because many of the positive genotoxicity studies were conducted using a metabolic activation system of plant origin. Atrazine alone or when tested in vitro in tests using animal metabolic systems was not genotoxic in most cases. Because plant metabolism is not generally considered important in developing a human hazard assessment, the relevance of the "plant-activated" tests in a risk analysis is doubtful.

Atrazine is not genotoxic in bacteria or yeast directly or with the typical rodent S9 activation. Yeast tests for mitotic crossing over and mutation do show positive responses, but only when tested with atrazine incubated with plant cell extracts. Bacteriophage T4 mutation and a *B. subtilis* test for repairable DNA damage were negative with atrazine alone. A *Streptomyces coelicolor* mutation assay was positive, but this assay appears to have very little reliability to discriminate true positives and false positives.

In vitro tests with mammalian cells also fail to respond to atrazine directly or with mammalian metabolism (aberrations and sister chromatid exchange tests in hamster cells were negative), but when hamster V79 cells were exposed to atrazine in the presence of plant cell extracts, the chemical was reported to be mutagenic. Positive unscheduled DNA synthesis (UDS) effects in EUE cells were also reported with atrazine plus plant cell extracts.

Atrazine was reported to be genotoxic directly in plants (mutations at the waxy locus in corn; locus in corn; chromosome aberrations in plant cells) and the mold *Aspergillus nidulans* (crossing over). Mutation studies in *Aspergillus* were conducted with plant cell extracts. In the presence of plant cell extracts, a mutation to 8 azaguanine resistance was reported for *Aspergillus*.

Atrazine was reported to induce sex-linked recessive lethal mutations in the fruit fly (*Drosophila melanogaster*) in one of two studies.

In vivo studies measuring chromosome aberrations in rodent bone marrow and dominant lethal mutations in the mouse were reported positive at dose levels of 2,000 and 1,500 mg/kg, respectively.

Positive responses in the Drosophila sex-linked recessive lethal assay (which measured gene mutations in germ cells) and the mouse dominant lethal assay (which measured chromosome alterations in germ cells) both indicate a potential for mutagenic hazard. Bone marrow chromosome aberration effects support this conclusion. The in vivo responses were observed only at very high levels of atrazine equal to or exceeding 1.5 gm/kg.

Bromacil

The mutagenicity studies submitted to EPA for the registration of bromacil were deemed unacceptable; therefore, no validated mutagenicity studies have been completed (EPA, 1984d).

Because of the potent mutagenicity of 5-bromouracil, which is a structurally related chemical, the metabolic fate of bromacil has been examined to determine whether the formation of 5-bromouracil occurs in vivo. Metabolic fate studies indicate that 5-bromouracil was not isolated from the urine and feces of rats exposed to bromacil or from the urine of bromacil production plant workers (DOE, 1983).

2,4-DP

A very limited assessment of the genotoxicity of 2,4-DP is available. 2,4-DP was nonmutagenic when tested in three nonactivated microbial assays (EPA, 1984f). 2,4-DP was not mutagenic to Salmonella in the Ames test. A sample was tested for induction repairable DNA damage in E. coli. The results were positive with metabolic activation. Positive were obtained when 2,4-DP was tested in the nonactivated Saccharomyces cerevisiae reverse mutation assay, the Saccharomyces cerevisiae mitotic gene conversion assay, and the activated E. coli assay for unscheduled DNA synthesis (EPA, 1984f).

A single in vivo micronucleus study in mice was conducted, but results were not reported because the study was concluded to be invalid by EPA.

Dicamba

Dicamba was nonmutagenic when tested in various microbial assays for gene mutations and a dominant lethal assay with mice (USDA, 1984). Positive mutagenic responses were observed when dicamba was tested in the B. subtilis and E. coli toxicity assays for primary DNA damage (USDA, 1984); however, these tests are not useful in determining human mutagenic potential.

CARCINOGENICITY

This subsection presents the details of oncogenicity tests conducted on amitrole, asulam, atrazine, bromacil, 2,4-D, 2,4-DP, glyphosate, picloram, and simazine.

Amitrole

Amitrole has been shown to induce a high incidence of thyroid tumors in laboratory animals. Amitrole also induces liver tumors in mice when fed at levels in excess of the maximum tolerated dose; it also produces thyroid carcinomas along with the liver tumors (EPA, 1984a; EPA, 1985a).

Amitrole is an antithyroid compound that resembles thiourea in its effect on the thyroid gland. Prolonged administration leads to a reduction in the levels of circulating thyroid hormones and a compensatory increase in the production of thyroid stimulating hormone (TSH). This results in enlargement of the thyroid (goiter) and in adenomatous (tumor growth of the glandular epithelium) changes.

There has been some disagreement among pathologists regarding the nature of the changes that have been induced in the thyroid glands of treated laboratory animals in some experiments. Some pathologists interpreted some of the changes to be cancerous, while others judged them to be nonmalignant (e.g., Jukes and Shaffer, 1960). In a 2-year rat feeding study conducted by Hazleton Laboratories, Inc., rats fed 100 ppm of amitrole had greater than 50 percent (15 of 27) incidence of thyroid adenoma. In rats fed 10 and 50 ppm, the incidence was lower (1 of 27 and 3 of 27, respectively), and there were no adenomas in the control group (Hodge et al., 1966; Jukes and Shaffer, 1960). In another 2-year rat feeding study by Bayer (1979, cited in EPA, 1985a), significant increases in thyroid tumors were observed at 100 ppm. Also, when rats were pulse-fed amitrole alternating with a control diet in an effort to minimize thyroid stimulation, significant increases in thyroid tumors were observed at the higher dose levels (Food and Drug Research Lab, 1981, cited in EPA, 1985a).

In another experiment, rats were fed 2,500 ppm in their drinking water for 70 weeks (Tsuda et al., 1976). Of 26 surviving rats, 100 percent had goiter development, and 73 percent had invasive thyroid lesions, and 11.5 percent had papillary adenoma. In two rats, liver damage occurred because of irregular proliferation of the bile ducts. Two other rat feeding studies and one hamster study found no increase in thyroid tumor incidence (EPA, 1985a).

Most exposures to workers and the public can be expected to be dermal, and dermal exposure in a mouse study did not yield similar effects. In a long-term (575 days) mouse study, subcutaneous injections (10 mg/mouse) and weekly skin applications in acetone produced no tumors (Hodge et al., 1966).

Other studies have shown that amitrole can produce liver tumors. For example, Feinstein et al. (1978) induced liver tumors by feeding high levels of amitrole to mice. When mice were fed 1 percent amitrole in their diets for 1 year, during 4 out of each 5 weeks, 100 percent of them developed liver tumors by 1 year after weaning. Only a few mice had thyroid tumors. However, this strain of mice (C3H) has a high natural incidence of liver tumors, and the concentration of amitrole given was so high that survival was affected for other reasons. Innes et al. (1969) also reported the induction of liver tumors in mice by amitrole. However, in this study, the doses also were so high (2,192 ppm) that survival was affected. Several other studies have reported no increase in the incidence of liver tumors (EPA, 1985a).

In some studies, amitrole has also been shown to cause pituitary tumors. In a 2-year rat study, pituitary tumors were increased at 100 ppm in females (Bayer, 1979, reported in EPA, 1985a). In another 2-year study, female rats had a significant incidence of pituitary tumors at the highest dose tested (100 ppm), whether it was administered continuously or intermittently (Food Drug Research Lab., 1981, reported in EPA, 1985a).

EPA has classified amitrole in Category B_2, indicating that it is a probable human carcinogen (EPA, 1985a). EPA has also stated in its Amitrole Toxicology Summary that the scientific evidence "strongly supports the use of a threshold approach in assessing the oncogenic risk of amitrole, realizing, however, that this is a radical departure from previously used risk assessments" (EPA, 1985a). EPA also concluded that amitrole is not mutagenic, and animal data suggest a "secondary carcinogenic" effect due to increased production of thyroid-stimulating hormone (EPA, 1985a). Consequently, EPA has suggested the use of a log-probit model in carcinogenic risk estimation for thyroid and pituitary tumors to better represent the threshold effect (EPA, 1985a). However, EPA has also used the multistage model in its risk assessment on thyroid tumors for comparison with the log-probit model predictions and for the assessment of risk from liver tumors (EPA, 1985a). One report not considered by EPA has suggested that amitrole may act via a mutation mechanism, indicating that caution may be warranted in low-dose extrapolation (Tsutsui et al., 1984).

Asulam

Asulam was oncogenic in one of three studies conducted. Two studies with mice resulted in no oncogenic effects after 18 months at the highest dose tested of 5,000 ppm (750 mg/kg/day).

A 107-week feeding study with rats resulted in a statistically significant increase in carcinoma of thyroid c cells at 1,000 ppm (20 mg/kg/day) in males. A significant increase in adrenal medullary hyperplasia was observed in males at 25,000 ppm (EPA, 1985d; EPA, 1983).

Atrazine

In an 18-month mouse feeding study, atrazine did not induce any tumors at 12.5 mg/kg/day (Innes et al., 1969); however oncogenic effects were observed in a 2-year rat feeding oncogenicity study. The following is a summary of atrazine oncogenicity information from EPA (1986):

> Study Results: Technical grade atrazine was evaluated for chronic oral toxicity and oncogenicity in Sprague-Dawley rats fed dietary concentrations of 0 (untreated control), 10, 70, 500, and 1,000 parts per million (ppm) for 2 years. A number of chronic toxicity symptoms were observed: reduced body weight for animals in the 500 and 1,000 ppm test groups, reduced red cell parameters (such as red blood cell count and hemoglobin) for females in the 1,000 ppm test group, and decreased glucose levels in animals fed 1,000 ppm. These data indicate a systemic toxicity NOEL of 70 ppm.
>
> There was a significant increase in total mammary tumors in female rats fed 70, 500, and 1,000 ppm atrazine. These tumors were observed as tissue masses or lumps even before the animals were sacrificed for pathologic examination.

Preliminary studies conducted to evaluate the carcinogenic potential of Fogard S^{R} (25 percent atrazine and 37.5 percent simazine) resulted in the formation of malignant lymphomas in mice after exposure to doses equivalent to 0.104 mg/kg of atrazine for a 7-month test period (Donna et al., 1981). The doses were given by subcutaneous and intraperitoneal injection. Tumor formation occurred as a result of both types of injection. The numbers of test animals were relatively small. Of the 24 mice receiving subcutaneous injections, 4 developed tumors, and of the 20 mice receiving intraperitoneal injections, 2 developed tumors. It is possible that the tumor formation observed in this study may be a function of the route of administration or a result of other chemicals in the formulation because atrazine and simazine have not been shown to be carcinogenic in other chronic studies, even at much higher doses.

N-Nitrosoatrazine

N-Nitroso derivatives of atrazine are carcinogenic to laboratory animals and mutagenic (Krull et al., 1980). Concerns have been raised over the potential for the nitrosation of atrazine to N-Nitrosoatrazine (NNA) under field conditions and over the potential toxicity of this compound.

Kearney et al. (1977) examined the formation and degradation of N-Nitrosoatrazine in soils and aquatic environments. Their results indicate that the formation of NNA is highly unlikely under normal application rates of atrazine (2 ppm) in agricultural soils of pH 5 to 7. They used elevated levels of nitrogen fertilizer (approximately 100 ppm) that are much higher than those used in forestry. Most of the NNA added to soil was converted relatively quickly to atrazine by denitrosation.

The degradation of NNA in aquatic environments is very rapid primarily because of photolysis (Wolfe et al., 1976).

Bromacil

Bromacil was oncogenic in one of two studies conducted. No oncogenic effects were observed in rats at doses up to 1,250 ppm (62.5 mg/kg/day) and 2 years of exposure. Liver tumors (hepatocellular adenomas) were observed in an 18-month study with mice at doses of 5,000 ppm (750 mg/kg/day) (EPA, 1985e).

2,4-D

A number of studies have assessed the carcinogenicity of 2,4-D, and thus far, there are no conclusive data demonstrating the carcinogenicity of 2,4-D (International Agency for Research on Cancer, 1977; Mullison, 1981; State of Minnesota, 1978, all as cited in USDA, 1984). However, there is also general agreement that none of these studies were adequate (EPA, 1982a; International Agency for Research on Cancer, 1977, as cited in USDA, 1984; WHO, 1984). At least one scientist, Dr. M. Rueber, disputes the conclusion that a carcinogenic effect of 2,4-D has not been shown (Rueber, 1979, as cited in BLM, 1985).

EPA has recently reviewed a long-term study on the oncogenic potential of 2,4-D. Preliminary findings indicate an increased incidence of brain tumors in rats. But EPA's review of the recent cancer study is not yet complete. EPA has requested an independent expert to review the brain tissue slides from this study and may also request a review of this study by the Scientific Advisory Panel. Thus a thorough review of this study may take months to complete. Therefore, EPA does not believe it is now appropriate to derive a specific numerical estimate of cancer potency based on the new data, but has stated, that from its preliminary review the level of cancer potency indicated by the reported results would be of about the same order of magnitude as the potency value based on the Hansen study that has been used in previous risk analyses (EPA, 1986c).

At 106 weeks, a preliminary pathology report from a recent mouse study found that 2,4-D was not oncogenic at dosages of 1, 15, and 45 mg/kg/day (Hazleton Laboratories, 1986).

Recently, Hoar et al. (1986) completed a case control epidemiologic study in Kansas, examining the risk of lymphoma and soft-tissue sarcoma in men from agricultural herbicide exposure. The study found no association between exposure and soft-tissue sarcoma or Hodgkin's disease, but observed a significant association for non-Hodgkin's lymphoma and phenoxyacetic acid herbicide exposure, especially 2,4-dichlorophenoxyacetic acid exposure. In addition, individuals exposed to herbicides for more than 20 days per year had a sixfold increase in non-Hodgkin's lymphoma. This study, however, suffers from the same inherent limitations as other case-control studies, mainly that it relies on the subject's and the next of kin's recall of exposure status. If recall is faulty, then misclassification occurs. Assessing exposure-disease relationships in these types of epidemiological studies is especially difficult (Thomas, 1986). For example, common exposures to other carcinogenic agents or other factors may result in disease but be undiscovered in the interview and confound the results. Thus, uncontrolled confounding factors in observational epidemiological studies can be particularly troublesome in interpreting the results. The apparent dose-response relationship observed in the Hoar et al. (1986) study for non-Hodgkin's lymphoma (NHL) is of public health concern and needs further examination.

A recent review of the Hoar et al. (1986) study conducted for EPA by Brian MacMahon, M.D., Ph.D. of the Harvard School of Public Health, concluded:

> In my opinion the weight of evidence does not support the conclusion that there is an association between exposure to 2,4-D and NHL. It is axiomatic that, except when relative risks are very high--and sometimes even then--no single study will establish an association between an exposure and an outcome. The acceptance of an association depends on a number of studies showing consistent results across populations and across different epidemiologic methods. The study of Hoar et al. is a strong study--strong enough on its own to establish a hypothesis of relationship of exposure to 2,4-D with some small proportion of cases of NHL--a hypothesis that clearly deserves attempts at refutation or support in other populations. When one attempts to place the results of this study among the results of those

> published previously, the picture becomes very confusing--much more so than if Hoar et al. had been the only study published. Taken as a whole, I believe that the weight of evidence indicates that an association between 2,4-D and NHL remains a hypothesis that is still to be tested. I am unwilling to speculate as to whether 2,4-D causes NHL (or some cases of NHL) until the evidence is clear that there is an association between them.

Now under way are at least two more studies that should be helpful in assessing risk to humans from the use of 2,4-D and other phenoxy herbicides (Colton, 1986). In view of the uncertainty regarding the carcinogenicity of 2,4-D, a cancer risk analysis was conducted in this risk assessment under the assumption that 2,4-D is carcinogenic.

2,4-DP

Two 2,4-DP oncogenicity studies have been submitted to EPA (EPA, 1984f). One of these, an 18-month study involving Swiss-Webster CD-1 mice, was negative because the rate of incidence of the tumors that were found in the mice were unrelated to increasing doses of 2,4-DP. Some increase in the rate of hepatomas was noted in the highest dose group (300 mg/kg), but this increase was attributed to liver trauma resulting from feeding a dose greater than the maximum tolerated dose of 2,4-DP.

A 2-year oncogenicity study involved Sprague-Dawley rats fed at dose levels of 0, 50, 100, and 200 mg/kg (EPA, 1986). In this study also, the highest dose group showed signs of general toxicity because they were fed more than the maximum tolerated dose of 2,4-DP. At 60 weeks, the high-dose group was reduced to 150 mg/kg because of general toxic effects. Females at all dose levels had high rates of tumor incidence, but they did not show a dose-related response. However, males showed a significant increase in the rate of incidence of malignant tumors, with a corresponding decrease in the rate of benign tumors. The males had increased levels of both pituitary carcinomas and thyroid carcinomas. Brain tumors were also observed in one group, in both males and females, although they were determined not to be treatment related.

Glyphosate

A 26-month rat feeding study found no oncogenic effects at doses up to 31 mg/kg day (EPA, 1984k). However, this study has been downgraded to supplementary by EPA because the maximum tolerated dose (MTD) was not reached at the high dose. Benign kidney tumors (renal tubular adenomas) were found at a highest dose level (30,000 ppm) in a 2-year mouse feeding study, however, the findings were equivocal. The EPA Science Advisory Panel (SAP) has reviewed all relevant data and concluded that the oncogenic potential of glyphosate could not be determined from existing data and proposed that the study be repeated to clarify these findings (EPA, 1986c).

The EPA is requiring that the mouse study be repeated with more animals in each test group to increase the statistical power of the study.

N-Nitrosoglyphosate

N-Nitroso derivatives of some herbicides are carcinogenic and mutagenic (Young and Khan, 1978; Braun et al., 1977). It has been suggested that the herbicide glyphosate may include N-Nitrosoglyphosate (NNG) as a trace contaminant, or that the compound may be formed in the environment after herbicidal application (Dost, 1983; Newton et al., 1984). However, EPA has determined that NNG does not occur as a contaminant in significant amounts in the herbicide glyphosate to pose a hazard to human health (Dost, 1983). Newton et al. (1984) found traces of NNG (approximately 0.02 ppm) in one foliage sample and one forest litter sample after aerial application of glyphosate; however, they concluded that this may have been because of the evaporation procedure used in the analysis.

Nitrosation in soil generally requires elevated nitrite levels and a pH of 3 to 4. Nitrite levels in forest area soils are generally much less that those in agricultural soils. Several studies have been conducted to measure the extent of nitrosation of glyphosate in soil with respect to temperature, pH, and organic matter content (Khan and Young, 1977; Young and Khan, 1978). NNG formed in several types of soil that were treated with glyphosate and nitrite. Levels of 5 ppm of NNG were reached when glyphosate was applied at approximately 185 ppm. This application rate is 90 to 100 times greater than normal rates. No NNG formed at glyphosate concentrations of 5 ppm and nitrite concentrations of 2 ppm. It was concluded that NNG is not likely to form in soils at the recommended application rates of 2.24 kg/ha, which is similar to application rates used in forestry.

Picloram

There is scientific controversy concerning the interpretation of studies on the potential of picloram to cause cancer. A rat oncogenicity study, during which test animals were exposed to an average of 14,875 ppm (743 mg/kg/day), was negative for oncogenic effects in males. Neoplastic nodules were observed in females at a statistically significant rate (EPA, 1984q). An oncogenic mouse study resulted in the absence of oncogenic effects at dietary exposure levels ranging from 5,000 to 15,000 ppm (750 mg/kg to 2,250 mg/kg) (EPA, 1984q and EPA, 1984m). Because there is some uncertainty regarding the potential for carcinogenicity of picloram, a worst-case approach was taken to calculate cancer risks.

The Gulf Research Institute conducted a carcinogenic bioassay of picloram in rats and mice for the National Cancer Institute (1978). The mouse study produced no indication of an oncogenic response resulting from dietary exposure. Exposure consisted of as much as 5,000-plus ppm in the diet for the greatest part of their lifetime (as cited in EPA, 1984m).

The rat study, however, was negative for oncogenic effects in males, while female rats exhibited a statistically significant increase over control rats in the rate of formation of neoplastic nodules in the liver. Exposures ranged on a time-weighted average up to 14,875 ppm in the diets (743 mg/kg) (as cited in EPA, 1984m). The study concluded that the findings were "suggestive of ability of the compound to induce benign tumors in livers of female Osborne-Mendel rats."

According to a classification scheme developed by the National Cancer Institute (NCI), picloram was classified as a chemical for which evidence of carcinogenicity in animals was equivocal at best (Griesmer and Cueto, 1980, cited in BLM, 1985a). However, one scientist has interpreted the data differently and has concluded that picloram was carcinogenic for all test animals except mice at the lowest dose (Rueber, 1981). This interpretation disagrees with the panel of experts who interpreted the data for the National Cancer Institute. More research on picloram's potential carcinogenicity is currently in progress at the Dow Chemical Company and is scheduled for completion in 1986. A new rodent (rat) oncogenicity study has been in progress since March 1982.

EPA (1984q) has stated that:

> It was found that some studies on long-term effects performed by Industrial Bio-Test (IBT) Laboratories were invalid due to improper laboratory practices. In addition, a long-term study in rats sponsored by the National Cancer Institute is considered of questionable value due to laboratory procedures. The results of this rat study suggest that picloram may induce benign liver tumors. Even if this study were accepted as positive, given the high doses needed to produce the effect, and the very low potential for human exposure from current uses, existing uses would not pose a significant risk of increased cancer in the population. The registrant is conducting a new rat study to clarify the ambiguous results of this NCI study.

Simazine

In a preliminary oncogenicity study, the herbicide Fogard S^R (25 percent atrazine and 37.5 percent simazine) was administered to mice for a 7-month test period; as a result, malignant lymphomas were induced in test animals treated subcutaneously and intraperitoneally (Donna et al., 1981). As noted previously regarding atrazine, tumor formation in this study may have resulted from other chemicals in the formulation, or it may be related to the route of administration, because chronic simazine and atrazine feeding studies have shown no oncogenic effects, even at higher doses.

ATTACHMENT B

DOSES TO WORKERS AND THE PUBLIC COMPUTED IN THE EXPOSURE ANALYSIS

Doses to workers for each of the application scenarios are given in mg/kg in the following tables. Doses to the public via each exposure route and for representative members of the public are given in micrograms/kg. Doses from accidental spraying to the public are given in micrograms/kg. Doses to workers and the public from spills are given in mg/kg.

DOSES TO WORKERS IN ROUTINE OPERATIONS

Table B-1

Doses to Workers (mg/kg)
Routine-Realistic Aerial, 40 Acres by Helicopter

HERBICIDE	PILOT	MIXER/LOADER	SUPERVISOR	OBSERVER
ATRAZINE	0.0755	0.1083	0.0116	0.0025
2,4-D	0.0302	0.0433	0.0046	0.0010
HEXAZINONE	0.0504	0.0722	0.0077	0.0016
PICLORAM	0.0010	0.0014	0.0001	0.0000
TRICLOPYR	0.0403	0.0578	0.0062	0.0013

Table B-2

Doses to Workers (mg/kg)
Large Aerial, 400 Acres by Fixed Wing, Routine-Worst Case

HERBICIDE	PILOT	MIXER/LOADER	SUPERVISOR	OBSERVER
ATRAZINE	0.6696	0.8536	0.1160	0.0207
2,4-D	0.4018	0.5122	0.0696	0.0124
HEXAZINONE	0.5022	0.6402	0.0870	0.0155
PICLORAM	0.0402	0.0512	0.0070	0.0012
TRICLOPYR	1.3392	1.7072	0.2320	0.0413

Table B-3

Doses to Backpack Sprayers (mg/kg)
Small Backpack, 6.0 Acres, Routine-Realistic Case

HERBICIDE	DOSE
AMITROLE	0.0033
ASULAM	0.1978
ATRAZINE	0.4946
BROMACIL	0.6595
2,4-D	0.1978
2,4-DP	0.2110
DALAPON	0.6595
DICAMBA	0.0412
DIURON	0.6595
FOSAMINE	0.4946
GLYPHOSATE	0.2473
HEXAZINONE	0.1846
PICLORAM	0.0079
SIMAZINE	0.3297
TEBUTHIURON	0.2473
TRICLOPYR	0.3297

Table B-4

Doses to Backpack Sprayers (mg/kg)
Large Backpack, 60 Acres, Routine-Worst Case

HERBICIDE	DOSE
AMITROLE	0.0310
ASULAM	2.0693
ATRAZINE	2.4782
BROMACIL	6.1955
2,4-D	1.4869
2,4-DP	1.7050
DALAPON	7.4346
DICAMBA	1.2391
DIURON	3.7173
FOSAMINE	7.1248
GLYPHOSATE	3.0978
HEXAZINONE	1.8587
PICLORAM	0.1190
SIMAZINE	2.8499
TEBUTHIURON	3.7173
TRICLOPYR	4.9564

Table B-5

Doses to Workers (mg/kg)
Small Right of Way, Routine-Realistic Case

HERBICIDE	APPLICATOR	MIX/LOADER	APPL/MIX/LOADER
AMITROLE	0.0001	0.0001	0.0001
ASULAM	0.0082	0.0084	0.0116
ATRAZINE	0.0103	0.0105	0.0145
BROMACIL	0.0137	0.0140	0.0193
2,4-D	0.0051	0.0052	0.0072
2,4-DP	0.0055	0.0056	0.0077
DALAPON	0.0137	0.0140	0.0193
DICAMBA	0.0017	0.0017	0.0024
DIURON	0.0137	0.0140	0.0193
FOSAMINE	0.0137	0.0140	0.0193
GLYPHOSATE	0.0069	0.0070	0.0096
HEXAZINONE	0.0086	0.0087	0.0120
PICLORAM	0.0002	0.0002	0.0002
SIMAZINE	0.0069	0.0070	0.0096
TEBUTHIURON	0.0075	0.0077	0.0106
TRICLOPYR	0.0069	0.0070	0.0096

Table B-6

Doses to Workers (mg/kg)
Large Right of Way, Routine-Worst Case

HERBICIDE	APPLICATOR	MIX/LOADER	APPL/MIX/LOADER
AMITROLE	0.0042	0.0024	0.0029
ASULAM	0.2652	0.1530	0.1787
ATRAZINE	0.4509	0.2601	0.3038
BROMACIL	0.5305	0.3060	0.3574
2,4-D	0.1305	0.0753	0.0879
2,4-DP	0.1698	0.0979	0.1144
DALAPON	0.5305	0.3060	0.3574
DICAMBA	0.0955	0.0551	0.0643
DIURON	0.8488	0.4896	0.5719
FOSAMINE	0.5676	0.3274	0.3824
GLYPHOSATE	0.2652	0.1530	0.1787
HEXAZINONE	0.3183	0.1836	0.2145
PICLORAM	0.0051	0.0029	0.0034
SIMAZINE	0.2440	0.1408	0.1644
TEBUTHIURON	0.2440	0.1408	0.1644
TRICLOPYR	0.4244	0.2448	0.2859

Table B-7

Doses to Workers (mg/kg)
Hand Application to Small Site,
Routine Realistic

HERBICIDE	HACK & SQUIRT	INJECTION BAR
AMITROLE	0.00056	0.00021
BROMACIL	0.11134	0.04235
2,4-D	0.06680	0.02541
2,4-DP	0.10689	0.04066
DICAMBA	0.05567	0.02118
DIURON	0.11134	0.04235
FOSAMINE	0.11134	0.04235
PICLORAM	0.00267	0.00102
TRICLOPYR	0.11134	0.04235

Table B-8

Doses to Workers (mg/kg)
Hand Application to Large Site,
Routine-Worst Case

HERBICIDE	HACK & SQUIRT	INJECTION BAR
AMITROLE	0.00631	0.00169
BROMACIL	1.26170	0.33728
2,4-D	0.75702	0.20237
2,4-DP	1.21123	0.32379
DICAMBA	0.63085	0.16864
DIURON	1.26170	0.33728
FOSAMINE	1.26170	0.33728
PICLORAM	0.03028	0.00809
TRICLOPYR	1.26170	0.33728

Table B-9

Doses in micrograms/kg by Exposure Type:
Routine-Realistic Aerial, 40 Acres by Helicopter

HERBICIDE	SPRAY DRIFT DERMAL	VEGETATION CONTACT HIKER	VEGETATION CONTACT PICKER	DRINK WATER	EATING BERRIES	EATING VEGS.	EATING DEER	EATING BIRD	EATING FISH
ATRAZINE	0.030	0.000	6.084	3.532	2.023	4.045	0.289	1.031	7.064
2,4-D	0.012	0.000	2.434	2.355	1.348	2.697	0.188	0.656	0.942
HEXAZINONE	0.020	0.000	4.056	2.355	1.348	2.697	0.192	0.687	0.942
PICLORAM	0.000	0.000	0.078	0.942	0.539	1.079	0.073	0.245	0.377
TRICLOPYR	0.016	0.000	3.245	1.884	1.079	2.158	0.154	0.550	0.754

Table B-10

Doses in micrograms/kg for Example People[1] for Routine-Realistic Aerial, 40 Acres by Helicopter

HERBICIDE	HIKER	BERRY PICKER	HUNTER	FISHERMAN	NEARBY RESIDENT
ATRAZINE	3.563	11.669	4.882	10.627	7.608
2,4-D	2.367	6.149	3.212	3.309	5.064
HEXAZINONE	2.375	7.779	3.255	3.317	5.072
PICLORAM	0.942	1.560	1.261	1.319	2.021
TRICLOPYR	1.900	6.223	2.604	2.654	4.058

[1] All of these people receive multiple exposures as shown in Table H-11.

Table B-11

Doses in micrograms/kg by Exposure Type for Large Aerial, 400 Acres by Fixed Wing, Routine-Worst Case

HERBICIDE	SPRAY DRIFT DERMAL	VEGETATION CONTACT HIKER	VEGETATION CONTACT PICKER	DRINK WATER	EATING BERRIES	EATING VEGS.	EATING DEER	EATING BIRD	EATING FISH
ATRAZINE	16.981	0.244	43.776	12.681	10.423	20.846	1.631	7.102	25.362
2,4-D	10.189	0.146	26.266	12.681	10.423	20.846	1.587	6.767	5.072
PICLORAM	1.019	0.015	2.627	15.851	13.028	26.057	1.907	7.883	6.340
TRICLOPYR	33.963	0.487	87.552	25.362	20.846	41.691	3.262	14.203	10.145

Table B-12

Doses in micrograms/kg for Example People[1] for Large Aerial, 400 Acres by Fixed Wing, Routine-Worst Case

HERBICIDE	HIKER	BERRY PICKER	HUNTER	FISHERMAN	NEARBY RESIDENT
ATRAZINE	29.906	83.861	38.638	55.267	50.751
2,4-D	23.016	59.558	31.370	28.088	43.861
HEXAZINONE	22.429	62.896	28.979	26.234	38.064
PICLORAM	16.885	32.525	26.674	23.225	42.941
TRICLOPYR	59.812	167.722	77.277	69.956	101.503

[1] All of these people receive multiple exposures as shown in Table H-11.

Table B-13

Doses in micrograms/kg by Exposure Type for Small Backpack, 6.0 Acres, Routine-Realistic Case

HERBICIDE	SPRAY DRIFT DERMAL	VEGETATION CONTACT HIKER	VEGETATION CONTACT PICKER	DRINK WATER	EATING BERRIES	EATING VEGS.	EATING DEER	EATING BIRD	EATING FISH
AMITROLE	0.002	0.000	0.007	0.166	0.306	0.612	0.038	0.109	0.066
ASULAM	0.107	0.002	0.423	0.100	0.184	0.367	0.024	0.073	0.040
ATRAZINE	0.267	0.004	1.057	0.249	0.459	0.918	0.060	0.184	0.498
BROMACIL	0.356	0.005	1.409	0.332	0.612	1.224	0.080	0.245	0.133
2,4-D	0.107	0.002	0.423	0.166	0.306	0.612	0.039	0.117	0.066
2,4-DP	0.114	0.002	0.451	0.166	0.306	0.612	0.039	0.118	0.066
DALAPON	0.356	0.005	1.409	0.332	0.612	1.224	0.080	0.245	0.133
DICAMBA	0.022	0.000	0.088	0.041	0.076	0.153	0.010	0.029	0.017
DIURON	0.356	0.005	1.409	0.332	0.612	1.224	0.080	0.245	2.654
FOSAMINE	0.267	0.004	1.057	0.249	0.459	0.918	0.060	0.184	0.100
GLYPHOSATE	0.134	0.002	0.528	0.124	0.229	0.459	0.030	0.092	0.050
HEXAZINONE	0.100	0.001	0.395	0.093	0.171	0.343	0.022	0.069	0.037
PICLORAM	0.004	0.000	0.017	0.083	0.153	0.306	0.019	0.055	0.033
SIMAZINE	0.178	0.003	0.705	0.166	0.306	0.612	0.040	0.122	0.066
TEBUTHIURON	0.134	0.002	0.528	0.124	0.229	0.459	0.030	0.092	0.498
TRICLOPYR	0.178	0.003	0.705	0.166	0.306	0.612	0.040	0.122	0.066

Table B-14

Doses in micrograms/kg for Example People[1] for Small Backpack, 6.0 Acres, Routine-Realistic Case

HERBICIDE	HIKER	BERRY PICKER	HUNTER	FISHERMAN	NEARBY RESIDENT
AMITROLE	0.168	0.481	0.315	0.234	0.780
ASULAM	0.208	0.813	0.305	0.248	0.575
ATRAZINE	0.520	2.032	0.763	1.017	1.438
BROMACIL	0.693	2.709	1.017	0.825	1.917
2,4-D	0.274	1.001	0.430	0.341	0.886
2,4-DP	0.281	1.037	0.438	0.348	0.893
DALAPON	0.693	2.709	1.017	0.825	1.917
DICAMBA	0.064	0.228	0.103	0.081	0.217
DIURON	0.693	2.709	1.017	3.346	1.917
FOSAMINE	0.520	2.032	0.763	0.619	1.438
GLYPHOSATE	0.260	1.016	0.381	0.310	0.719
HEXAZINONE	0.194	0.759	0.285	0.231	0.537
PICLORAM	0.087	0.257	0.161	0.120	0.393
SIMAZINE	0.346	1.354	0.509	0.413	0.958
TEBUTHIURON	0.260	1.016	0.381	0.757	0.719
TRICLOPYR	0.346	1.354	0.509	0.413	0.958

[1] All of these people receive multiple exposures as shown in Table H-11.

Table B-15

Doses in micrograms/kg by Exposure Type for Large Backpack, 60 Acres, Routine-Worst Case

HERBICIDE	SPRAY DRIFT DERMAL	VEGETATION CONTACT HIKER	VEGETATION CONTACT PICKER	DRINK WATER	EATING BERRIES	EATING VEGS.	EATING DEER	EATING BIRD	EATING FISH
AMITROLE	0.009	0.000	0.022	0.477	0.922	1.843	0.116	0.339	0.191
ASULAM	0.572	0.008	1.475	0.319	0.616	1.231	0.081	0.255	0.128
ATRAZINE	0.685	0.010	1.766	0.382	0.737	1.475	0.097	0.305	0.764
BROMACIL	1.713	0.025	4.416	0.955	1.843	3.687	0.242	0.762	0.382
2,4-D	0.411	0.006	1.060	0.382	0.737	1.475	0.095	0.291	0.153
2,4-DP	0.471	0.007	1.215	0.411	0.793	1.585	0.102	0.315	0.164
DALAPON	2.056	0.029	5.299	1.146	2.212	4.424	0.290	0.915	0.458
DICAMBA	0.343	0.005	0.883	0.382	0.737	1.475	0.095	0.288	0.153
DIURON	1.028	0.015	2.650	0.573	1.106	2.212	0.145	0.457	4.584
FOSAMINE	1.970	0.028	5.078	1.098	2.120	4.240	0.278	0.876	0.439
GLYPHOSATE	0.857	0.012	2.208	0.477	0.922	1.843	0.121	0.381	0.191
HEXAZINONE	0.514	0.007	1.325	0.286	0.553	1.106	0.073	0.229	0.115
PICLORAM	0.033	0.000	0.085	0.382	0.737	1.475	0.093	0.273	0.153
SIMAZINE	0.788	0.011	2.031	0.439	0.848	1.696	0.111	0.351	0.176
TEBUTHIURON	1.028	0.015	2.650	0.573	1.106	2.212	0.145	0.457	2.292
TRICLOPYR	1.370	0.020	3.533	0.764	1.475	2.949	0.194	0.610	0.306

Table B-16

Doses in micrograms/kg for Example People[1] for Large Backpack, 60 Acres, Routine-Worst Case

HERBICIDE	HIKER	BERRY PICKER	HUNTER	FISHERMAN	NEARBY RESIDENT
AMITROLE	0.486	1.430	0.941	0.677	2.330
ASULAM	0.899	2.982	1.235	1.027	2.131
ATRAZINE	1.077	3.571	1.479	1.841	2.552
BROMACIL	2.693	8.927	3.697	3.075	6.379
2,4-D	0.799	2.590	1.185	0.952	2.274
2,4-DP	0.889	2.890	1.306	1.053	2.474
DALAPON	3.231	10.713	4.436	3.690	7.655
DICAMBA	0.730	2.345	1.112	0.882	2.204
DIURON	1.616	5.356	2.218	6.200	3.828
FOSAMINE	3.096	10.267	4.251	3.536	7.336
GLYPHOSATE	1.346	4.464	1.848	1.537	3.190
HEXAZINONE	0.808	2.678	1.109	0.922	1.914
PICLORAM	0.415	1.237	0.781	0.568	1.890
SIMAZINE	1.239	4.107	1.701	1.414	2.935
TEBUTHIURON	1.616	5.356	2.218	3.908	3.828
TRICLOPYR	2.154	7.142	2.957	2.460	5.103

[1] All of these people receive multiple exposures as shown in Table H-11.

Table B-17

Doses in micrograms/kg by Exposure Type for Small Right of Way, Routine-Realistic Case

HERBICIDE	SPRAY DRIFT DERMAL	VEGETATION CONTACT HIKER	VEGETATION CONTACT PICKER	DRINK WATER	EATING BERRIES	EATING VEGS.	EATING DEER	EATING BIRD	EATING FISH
AMITROLE	0.000	0.000	0.002	0.074	0.102	0.204	0.012	0.030	0.030
ASULAM	0.041	0.001	0.224	0.089	0.123	0.245	0.015	0.041	0.036
ATRAZINE	0.052	0.001	0.280	0.112	0.153	0.307	0.019	0.051	0.223
BROMACIL	0.069	0.001	0.373	0.149	0.204	0.409	0.025	0.068	0.060
2,4-D	0.026	0.000	0.140	0.093	0.128	0.256	0.016	0.041	0.037
2,4-DP	0.028	0.000	0.149	0.093	0.128	0.256	0.016	0.041	0.037
DALAPON	0.069	0.001	0.373	0.149	0.204	0.409	0.025	0.068	0.060
DICAMBA	0.009	0.000	0.047	0.037	0.051	0.102	0.006	0.016	0.015
DIURON	0.069	0.001	0.373	0.149	0.204	0.409	0.025	0.068	1.191
FOSAMINE	0.069	0.001	0.373	0.149	0.204	0.409	0.025	0.068	0.060
GLYPHOSATE	0.034	0.000	0.187	0.074	0.102	0.204	0.013	0.034	0.030
HEXAZINONE	0.043	0.001	0.233	0.093	0.128	0.256	0.016	0.042	0.037
PICLORAM	0.001	0.000	0.004	0.037	0.051	0.102	0.006	0.015	0.015
SIMAZINE	0.034	0.000	0.187	0.074	0.102	0.204	0.013	0.034	0.030
TEBUTHIURON	0.038	0.001	0.205	0.082	0.112	0.225	0.014	0.037	0.327
TRICLOPYR	0.034	0.000	0.187	0.074	0.102	0.204	0.013	0.034	0.030

Table B-18

Doses in micrograms/kg for Example People[1] for Small Right of Way, Routine-Realistic Case

HERBICIDE	HIKER	BERRY PICKER	HUNTER	FISHERMAN	NEARBY RESIDENT
AMITROLE	0.075	0.179	0.117	0.105	0.279
ASULAM	0.131	0.477	0.187	0.167	0.377
ATRAZINE	0.164	0.597	0.234	0.387	0.471
BROMACIL	0.219	0.796	0.312	0.278	0.628
2,4-D	0.119	0.387	0.175	0.156	0.375
2,4-DP	0.121	0.398	0.177	0.158	0.377
DALAPON	0.219	0.796	0.312	0.278	0.628
DICAMBA	0.046	0.144	0.068	0.061	0.148
DIURON	0.219	0.796	0.312	1.409	0.628
FOSAMINE	0.219	0.796	0.312	0.278	0.628
GLYPHOSATE	0.109	0.398	0.156	0.139	0.314
HEXAZINONE	0.137	0.497	0.195	0.174	0.392
PICLORAM	0.038	0.094	0.059	0.053	0.140
SIMAZINE	0.109	0.398	0.156	0.139	0.314
TEBUTHIURON	0.120	0.438	0.172	0.448	0.345
TRICLOPYR	0.109	0.398	0.156	0.139	0.314

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[1] All of these people receive multiple exposures as shown in Table H-11.

Table B-19

Doses in micrograms/kg by Exposure Type for
Large Right of Way, Routine-Worst Case

HERBICIDE	SPRAY DRIFT DERMAL	VEGETATION CONTACT HIKER	VEGETATION CONTACT PICKER	DRINK WATER	EATING BERRIES	EATING VEGS.	EATING DEER	EATING BIRD	EATING FISH
AMITROLE	0.005	0.000	0.012	0.398	0.620	1.240	0.075	0.197	0.159
ASULAM	0.300	0.004	0.773	0.249	0.388	0.775	0.049	0.138	0.100
ATRAZINE	0.510	0.007	1.314	0.423	0.659	1.318	0.083	0.234	0.846
BROMACIL	0.600	0.009	1.546	0.498	0.775	1.550	0.098	0.275	0.199
2,4-D	0.147	0.002	0.380	0.204	0.318	0.636	0.040	0.108	0.082
2,4-DP	0.192	0.003	0.495	0.249	0.388	0.775	0.048	0.132	0.100
DALAPON	0.600	0.009	1.546	0.498	0.775	1.550	0.098	0.275	0.199
DICAMBA	0.108	0.002	0.278	0.179	0.279	0.558	0.035	0.094	0.072
DIURON	0.959	0.014	2.473	0.796	1.240	2.481	0.157	0.441	6.372
FOSAMINE	0.642	0.009	1.654	0.533	0.829	1.659	0.105	0.295	0.213
GLYPHOSATE	0.300	0.004	0.773	0.249	0.388	0.775	0.049	0.138	0.100
HEXAZINONE	0.360	0.005	0.927	0.299	0.465	0.930	0.059	0.165	0.119
PICLORAM	0.006	0.000	0.015	0.100	0.155	0.310	0.019	0.049	0.040
SIMAZINE	0.276	0.004	0.711	0.229	0.357	0.713	0.045	0.127	0.092
TEBUTHIURON	0.276	0.004	0.711	0.229	0.357	0.713	0.045	0.127	0.916
TRICLOPYR	0.480	0.007	1.236	0.398	0.620	1.240	0.078	0.220	0.159

Table B-20

Doses in micrograms/kg for Example People[1] for Large Right of Way, Routine-Worst Case

HERBICIDE	HIKER	BERRY PICKER	HUNTER	FISHERMAN	NEARBY RESIDENT
AMITROLE	0.403	1.036	0.675	0.562	1.643
ASULAM	0.553	1.709	0.740	0.653	1.328
ATRAZINE	0.940	2.905	1.258	1.786	2.258
BROMACIL	1.106	3.418	1.479	1.305	2.656
2,4-D	0.354	1.050	0.501	0.435	0.989
2,4-DP	0.444	1.323	0.624	0.543	1.219
DALAPON	1.106	3.418	1.479	1.305	2.656
DICAMBA	0.289	0.844	0.417	0.360	0.847
DIURON	1.770	5.469	2.367	8.141	4.250
FOSAMINE	1.183	3.657	1.583	1.396	2.842
GLYPHOSATE	0.553	1.709	0.740	0.653	1.328
HEXAZINONE	0.664	2.051	0.888	0.783	1.594
PICLORAM	0.105	0.275	0.174	0.145	0.415
SIMAZINE	0.509	1.572	0.681	0.600	1.222
TEBUTHIURON	0.509	1.572	0.681	1.425	1.222
TRICLOPYR	0.885	2.735	1.184	1.044	2.125

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[1] All of these people receive multiple exposures as shown in Table H-11.

DOSES TO THE PUBLIC FROM ACCIDENTAL-WORST CASE

Table B-21

Doses in micrograms/kg from Items Receiving the Full Per Acre
Application Rate by Exposure Type
Accidental-Worst Case

HERBICIDE	DIRECT DERMAL	REENTRY HIKER	REENTRY PICKER	DRINK WATER	EATING BERRIES	EATING VEGS.	EATING DEER	EATING BIRD	EATING FISH
AMITROLE	3.	0.	9.	117.	93.	194.	19.	116.	47.
ASULAM	209.	3.	538.	73.	58.	121.	13.	83.	29.
ATRAZINE	355.	5.	914.	125.	99.	206.	22.	141.	249.
BROMACIL	417.	6.	1075.	147.	116.	242.	26.	165.	59.
2,4-D	103.	1.	264.	60.	48.	99.	10.	64.	24.
2,4-DP	133.	2.	344.	73.	58.	121.	13.	79.	29.
DALAPON	417.	6.	1075.	147.	116.	242.	26.	165.	59.
DICAMBA	83.	1.	215.	59.	47.	97.	10.	62.	23.
DIURON	667.	10.	1720.	235.	186.	387.	42.	265.	1878.
FOSAMINE	501.	7.	1290.	176.	140.	290.	31.	199.	70.
GLYPHOSATE	209.	3.	538.	73.	58.	121.	13.	83.	29.
HEXAZINONE	250.	4.	645.	88.	70.	145.	16.	99.	35.
PICLORAM	10.	0.	26.	73.	58.	121.	12.	73.	29.
SIMAZINE	209.	3.	538.	73.	58.	121.	13.	83.	29.
TEBUTHIURON	250.	4.	645.	88.	70.	145.	16.	99.	352.
TRICLOPYR	334.	5.	860.	117.	93.	194.	21.	132.	47.

Table B-22

Doses in micrograms/kg for Example People[1] for Accidental-Worst Case Spraying

HERBICIDE	HIKER	BERRY PICKER	HUNTER	FISHERMAN	NEARBY RESIDENT
AMITROLE	121.	222.	256.	168.	314.
ASULAM	285.	878.	381.	314.	406.
ATRAZINE	484.	1492.	647.	734.	690.
BROMACIL	570.	1755.	761.	628.	812.
2,4-D	164.	475.	239.	188.	263.
2,4-DP	209.	609.	300.	238.	330.
DALAPON	570.	1755.	761.	628.	812.
DICAMBA	143.	404.	215.	167.	240.
DIURON	912.	2809.	1218.	2790.	1299.
FOSAMINE	684.	2107.	914.	754.	974.
GLYPHOSATE	285.	878.	381.	314.	406.
HEXAZINONE	342.	1053.	457.	377.	487.
PICLORAM	84.	167.	168.	113.	204.
SIMAZINE	285.	878.	381.	314.	406.
TEBUTHIURON	342.	1053.	457.	694.	487.
TRICLOPYR	456.	1404.	609.	503.	649.

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[1] All of these people receive multiple exposures as shown in Table H-11.

DOSES TO WORKERS AND THE PUBLIC FROM SPILLS

Table B-23

Doses from Herbicide Spills (mg/kg)

HERBICIDE	SPILL OF ONE PINT CONCENTRATE ON SKIN	SPILL OF ONE PINT TANK MIX ON SKIN	HELICOPTER[1] DUMP INTO POND	HELICOPTER[1] DUMP INTO RESERVOIR	TRUCK[1] SPILL INTO POND	TRUCK[1] SPILL INTO RESERVOIR
AMITROLE	1.20	0.24	-----	-----	1.4730	0.0460
ASULAM	240.00	20.04	-----	-----	1.2300	0.0384
ATRAZINE	240.00	24.00	0.0737	0.0023	1.4730	0.0460
BROMACIL	240.00	12.00	-----	-----	0.7365	0.0230
2,4-D	144.00	14.40	0.0737	0.0023	1.4730	0.0460
2,4-DP	230.40	9.60	-----	-----	0.9206	0.0288
DALAPON	-----	60.00	-----	-----	3.6825	0.1151
DICAMBA	120.00	12.00	-----	-----	1.4730	0.0460
DIURON	240.00	19.20	-----	-----	1.1784	0.0368
FOSAMINE	240.00	72.00	-----	-----	4.4191	0.1381
GLYPHOSATE	180.00	30.00	-----	-----	1.8413	0.0575
HEXAZINONE	120.00	18.00	0.0552	0.0017	1.1048	0.0345
PICLORAM	5.76	1.44	0.0921	0.0029	1.8413	0.0575
SIMAZINE	240.00	30.00	-----	-----	1.8413	0.0575
TEBUTHIURON	-----	36.00	-----	-----	2.2095	0.0690
TRICLOPYR	240.00	48.00	0.1473	0.0046	2.9460	0.0921

[1] Assuming 1 liter of water drunk per day.

LIFETIME DOSES IN ROUTINE OPERATIONS

Table B-24

Lifetime Doses for Exposed Workers (mg/kg/day)

	Exposures per Lifetime	Average Daily Dose for Exclusive Use of						
		2,4-D	2,4-DP	Asulam	Bromacil	Picloram	Amitrole	Glyphosate
Realistic Number of Exposures								
Pilot	30	5.73E-05	4.45E-05	----	----	3.44E-06	----	----
Mixer/Loader	30	7.84E-05	6.13E-05	----	----	4.55E-06	----	----
Supervisor	30	9.24E-06	7.12E-06	----	----	5.74E-07	----	----
Observer	30	1.82E-06	1.42E-06	----	----	1.08E-07	----	----
Backpack	50	5.13E-04	5.59E-04	5.70E-04	1.83E-03	2.64E-05	9.16E-06	7.63E-04
R-O-W Sprayer	45	2.01E-05	2.41E-05	3.71E-05	6.97E-05	7.24E-07	4.88E-07	3.48E-05
R-O-W Mix/L	45	1.54E-05	1.80E-05	2.75E-05	5.03E-05	5.39E-07	3.32E-07	2.52E-05
R-O-W AP/M/L	45	1.98E-05	2.30E-05	3.51E-05	6.37E-05	6.89E-07	4.13E-07	3.19E-05
Hack & Squirt	70	2.78E-04	4.44E-04	----	4.63E-04	1.11E-05	2.31E-06	----
Injection Bar	70	9.39E-05	1.50E-04	----	1.56E-04	3.75E-06	7.82E-07	----
Worst Case Number of Exposures								
Pilot	288	5.50E-04	4.27E-04	----	----	3.30E-05	----	----
Mixer/Loader	288	7.53E-04	5.88E-04	----	----	4.37E-05	----	----
Supervisor	288	8.87E-05	6.84E-05	----	----	5.51E-06	----	----
Observer	288	1.75E-05	1.36E-05	----	----	1.03E-06	----	----
Backpack	440	4.52E-03	4.92E-03	5.02E-03	1.61E-02	2.32E-04	8.06E-05	6.71E-03
R-O-W Sprayer	416	1.86E-04	2.23E-04	3.43E-04	6.44E-04	6.69E-06	4.52E-06	3.22E-04
R-O-W Mix/L	416	1.42E-04	1.66E-04	2.54E-04	4.65E-04	4.98E-06	3.07E-06	2.33E-04
R-O-W AP/M/L	416	1.83E-04	2.12E-04	3.24E-04	5.89E-04	6.37E-06	3.82E-06	2.95E-04
Hack & Squirt	480	1.90E-03	3.05E-03	----	3.17E-03	7.61E-05	1.59E-05	----
Injection Bar	480	6.44E-04	1.03E-03	----	1.07E-03	2.57E-05	5.36E-06	----

Table B-25

Lifetime Doses for Exposed Public (mg/kg/day)
Realistic Aerial, 40 Acres by Helicopter

	Exposures per Lifetime	Average Daily Dose for Exclusive Use of 2,4-D	Average Daily Dose for Exclusive Use of Picloram
For a Single Exposure			
Dermal, Spray	1	4.71E-10	1.51E-11
Vegetation Contact			
Hiker	1	6.76E-12	2.16E-13
Picker	1	9.52E-08	3.05E-09
Drinking Water	1	9.22E-08	3.69E-08
Eating Berries	1	5.28E-08	2.11E-08
Eating Vegets.	1	1.06E-07	4.22E-08
Eating Deer	1	7.37E-09	2.86E-09
Eating Fish	1	3.69E-08	1.47E-08
Combined Routes of Exposure			
Hiker	1	9.26E-08	3.69E-08
Berrypicker	1	2.41E-07	6.10E-08
Hunter	1	1.26E-07	4.93E-08
Fisherman	1	1.30E-07	5.16E-08
Resident	1	1.98E-07	7.91E-08
For 30 Exposures			
Dermal, Spray	30	1.41E-08	4.52E-10
Vegetation Contact			
Hiker	30	2.03E-10	6.49E-12
Picker	30	2.86E-06	9.14E-08
Drinking Water	30	2.76E-06	1.11E-06
Eating Berries	30	1.58E-06	6.33E-07
Eating Vegets.	30	3.17E-06	1.27E-06
Eating Deer	30	2.21E-07	8.58E-08
Eating Fish	30	1.11E-06	4.42E-07
Combined Routes of Exposure			
Hiker	30	2.78E-06	1.11E-06
Berrypicker	30	7.22E-06	1.83E-06
Hunter	30	3.77E-06	1.48E-06
Fisherman	30	3.89E-06	1.55E-06
Resident	30	5.95E-06	2.37E-06

Table B-26

Lifetime Doses for Exposed Public (mg/kg/day)
Large Aerial, 400 Acres by Fixed Wing, Worst Case

	Exposures per Lifetime	Average Daily Dose for Exclusive Use of	
		2,4-D	Picloram
For a Single Exposure			
Dermal, Spray	1	3.99E-07	3.99E-08
Vegetation Contact			
Hiker	1	5.72E-09	5.72E-10
Picker	1	1.03E-06	1.03E-07
Drinking Water	1	4.96E-07	6.20E-07
Eating Berries	1	4.08E-07	5.10E-07
Eating Vegets.	1	8.16E-07	1.02E-06
Eating Deer	1	6.21E-08	7.46E-08
Eating Fish	1	1.99E-07	2.48E-07
Combined Routes of Exposure			
Hiker	1	9.01E-07	6.61E-07
Berrypicker	1	2.33E-06	1.27E-06
Hunter	1	1.23E-06	1.04E-06
Fisherman	1	1.10E-06	9.09E-07
Resident	1	1.72E-06	1.68E-06
For 30 Exposures			
Dermal, Spray	30	1.20E-05	1.20E-06
Vegetation Contact			
Hiker	30	1.72E-07	1.72E-08
Picker	30	3.08E-05	3.08E-06
Drinking Water	30	1.49E-05	1.86E-05
Eating Berries	30	1.22E-05	1.53E-05
Eating Vegets.	30	2.45E-05	3.06E-05
Eating Deer	30	1.86E-06	2.24E-06
Eating Fish	30	5.96E-06	7.44E-06
Combined Routes of Exposure			
Hiker	30	2.70E-05	1.98E-05
Berrypicker	30	6.99E-05	3.82E-05
Hunter	30	3.68E-05	3.13E-05
Fisherman	30	3.30E-05	2.73E-05
Resident	30	5.15E-05	5.04E-05

Table B-27

Lifetime Doses for Exposed Public (mg/kg/day)
Small Backpack, 6.0 Acres, Reaslitic Case

	Exposures per Lifetime	Average Daily Dose for Exclusive Use of						
		2,4-D	2,4-DP	Asulam	Bromacil	Picloram	Amitrole	Glyphosate
For a Single Exposure								
Dermal, Spray	1	4.18E-09	4.46E-09	4.18E-09	1.39E-08	1.67E-10	6.97E-11	5.23E-09
Vegetation Contact								
Hiker	1	6.00E-11	6.40E-11	6.00E-11	2.00E-10	2.40E-12	1.00E-12	7.50E-11
Picker	1	1.65E-08	1.77E-08	1.65E-08	5.52E-08	6.62E-10	2.76E-10	2.07E-08
Drinking Water	1	6.49E-09	6.49E-09	3.89E-09	1.30E-08	3.25E-09	6.49E-09	4.87E-09
Eating Berries	1	1.20E-08	1.20E-08	7.19E-09	2.40E-08	5.99E-09	1.20E-08	8.98E-09
Eating Vegets.	1	2.40E-08	2.40E-08	1.44E-08	4.79E-08	1.20E-08	2.40E-08	1.80E-08
Eating Deer	1	1.53E-09	1.53E-09	9.35E-10	3.12E-09	7.46E-10	1.49E-09	1.17E-09
Eating Fish	1	2.60E-09	2.60E-09	1.56E-09	5.19E-09	1.30E-09	2.60E-09	1.95E-09
Combined Routes of Exposure								
Hiker	1	1.07E-08	1.10E-08	8.13E-09	2.71E-08	3.42E-09	6.56E-09	1.02E-08
Berrypicker	1	3.92E-08	4.06E-08	3.18E-08	1.06E-07	1.01E-08	1.88E-08	3.98E-08
Hunter	1	1.68E-08	1.71E-08	1.19E-08	3.98E-08	6.31E-09	1.23E-08	1.49E-08
Fisherman	1	1.33E-08	1.36E-08	9.69E-09	3.23E-08	4.71E-09	9.16E-09	1.21E-08
Resident	1	3.47E-08	3.50E-08	2.25E-08	7.50E-08	1.54E-08	3.05E-08	2.81E-08
For 30 Exposures								
Dermal, Spray	30	1.25E-07	1.34E-07	1.25E-07	4.18E-07	5.02E-09	2.09E-09	1.57E-07
Vegetation Contact								
Hiker	30	1.80E-09	1.92E-09	1.80E-09	6.00E-09	7.20E-11	3.00E-11	2.25E-09
Picker	30	4.96E-07	5.30E-07	4.96E-07	1.65E-06	1.99E-08	8.27E-09	6.21E-07
Drinking Water	30	1.95E-07	1.95E-07	1.17E-07	3.89E-07	9.74E-08	1.95E-07	1.46E-07
Eating Berries	30	3.59E-07	3.59E-07	2.16E-07	7.19E-07	1.80E-07	3.59E-07	2.69E-07
Eating Vegets.	30	7.19E-07	7.19E-07	4.31E-07	1.44E-06	3.59E-07	7.19E-07	5.39E-07
Eating Deer	30	4.59E-08	4.60E-08	2.81E-08	9.35E-08	2.24E-08	4.47E-08	3.51E-08
Eating Fish	30	7.79E-08	7.79E-08	4.67E-08	1.56E-07	3.89E-08	7.79E-08	5.84E-08
Combined Routes of Exposure								
Hiker	30	3.22E-07	3.30E-07	2.44E-07	8.13E-07	1.02E-07	1.97E-07	3.05E-07
Berrypicker	30	1.18E-06	1.22E-06	9.54E-07	3.18E-06	3.02E-07	5.64E-07	1.19E-06
Hunter	30	5.05E-07	5.14E-07	3.58E-07	1.19E-06	1.89E-07	3.70E-07	4.48E-07
Fisherman	30	4.00E-07	4.08E-07	2.91E-07	9.69E-07	1.41E-07	2.75E-07	3.63E-07
Resident	30	1.04E-06	1.05E-06	6.75E-07	2.25E-06	4.62E-07	9.15E-07	8.44E-07

Table B-28

Lifetime Doses for Exposed Public (mg/kg/day)
Large Backpack, 60 Acres, Worst Case

	Exposures per Lifetime	Average Daily Dose for Exclusive Use of						
		2,4-D	2,4-DP	Asulam	Bromacil	Picloram	Amitrole	Glyphosate
For a Single Exposure								
Dermal, Spray	1	1.61E-08	1.85E-08	2.24E-08	6.70E-08	1.29E-09	3.35E-10	3.35E-08
Vegetation Contact								
Hiker	1	2.31E-10	2.65E-10	3.21E-10	9.62E-10	1.85E-11	4.81E-12	4.81E-10
Picker	1	4.15E-08	4.76E-08	5.77E-08	1.73E-07	3.32E-09	8.64E-10	8.64E-08
Drinking Water	1	1.50E-08	1.61E-08	1.25E-08	3.74E-08	1.50E-08	1.87E-08	1.87E-08
Eating Berries	1	2.89E-08	3.10E-08	2.41E-08	7.21E-08	2.89E-08	3.61E-08	3.61E-08
Eating Vegets.	1	5.77E-08	6.20E-08	4.82E-08	1.44E-07	5.77E-08	7.21E-08	7.21E-08
Eating Deer	1	3.72E-09	4.01E-09	3.16E-09	9.47E-09	3.62E-09	4.52E-09	4.74E-09
Eating Fish	1	5.98E-09	6.43E-09	4.99E-09	1.50E-08	5.98E-09	7.48E-09	7.48E-09
Combined Routes of Exposure								
Hiker	1	3.13E-08	3.48E-08	3.52E-08	1.05E-07	1.63E-08	1.90E-08	5.27E-08
Berrypicker	1	1.01E-07	1.13E-07	1.17E-07	3.49E-07	4.84E-08	5.60E-08	1.75E-07
Hunter	1	4.64E-08	5.11E-08	4.83E-08	1.45E-07	3.06E-08	3.68E-08	7.23E-08
Fisherman	1	3.73E-08	4.12E-08	4.02E-08	1.20E-07	2.22E-08	2.65E-08	6.02E-08
Resident	1	8.90E-08	9.68E-08	8.34E-08	2.50E-07	7.40E-08	9.12E-08	1.25E-07
For 30 Exposures								
Dermal, Spray	30	4.83E-07	5.54E-07	6.72E-07	2.01E-06	3.86E-08	1.01E-08	1.01E-06
Vegetation Contact								
Hiker	30	6.93E-09	7.94E-09	9.64E-09	2.89E-08	5.54E-10	1.44E-10	1.44E-08
Picker	30	1.24E-06	1.43E-06	1.73E-06	5.19E-06	9.96E-08	2.59E-08	2.59E-06
Drinking Water	30	4.49E-07	4.82E-07	3.75E-07	1.12E-06	4.49E-07	5.61E-07	5.61E-07
Eating Berries	30	8.66E-07	9.31E-07	7.23E-07	2.16E-06	8.66E-07	1.08E-06	1.08E-06
Eating Vegets.	30	1.73E-06	1.86E-06	1.45E-06	4.33E-06	1.73E-06	2.16E-06	2.16E-06
Eating Deer	30	1.12E-07	1.20E-07	9.49E-08	2.84E-07	1.09E-07	1.36E-07	1.42E-07
Eating Fish	30	1.79E-07	1.93E-07	1.50E-07	4.49E-07	1.79E-07	2.24E-07	2.24E-07
Combined Routes of Exposure								
Hiker	30	9.38E-07	1.04E-06	1.06E-06	3.16E-06	4.88E-07	5.71E-07	1.58E-06
Berrypicker	30	3.04E-06	3.39E-06	3.50E-06	1.05E-05	1.45E-06	1.68E-06	5.24E-06
Hunter	30	1.39E-06	1.53E-06	1.45E-06	4.34E-06	9.17E-07	1.10E-06	2.17E-06
Fisherman	30	1.12E-06	1.24E-06	1.21E-06	3.61E-06	6.67E-07	7.95E-07	1.81E-06
Resident	30	2.67E-06	2.91E-06	2.50E-06	7.49E-06	2.22E-06	2.74E-06	3.75E-06

Table B-29

Lifetime Doses for Exposed Public (mg/kg/day)
Small Right of Way, Realistic Case

	Exposures per Lifetime	Average Daily Dose for Exclusive Use of						
		2,4-D	2,4-DP	Asulam	Bromacil	Picloram	Amitrole	Glyphosate
For a Single Exposure								
Dermal, Spray	1	1.01E-09	1.08E-09	1.62E-09	2.70E-09	3.24E-11	1.35E-11	1.35E-09
Vegetation Contact								
Hiker	1	1.45E-11	1.55E-11	2.32E-11	3.87E-11	4.65E-13	1.94E-13	1.94E-11
Picker	1	5.48E-09	5.84E-09	8.77E-09	1.46E-08	1.75E-10	7.30E-11	7.30E-09
Drinking Water	1	3.64E-09	3.64E-09	3.49E-09	5.82E-09	1.46E-09	2.91E-09	2.91E-09
Eating Berries	1	5.00E-09	5.00E-09	4.80E-09	8.00E-09	2.00E-09	4.00E-09	4.00E-09
Eating Vegets.	1	1.00E-08	1.00E-08	9.60E-09	1.60E-08	4.00E-09	8.00E-09	8.00E-09
Eating Deer	1	6.14E-10	6.15E-10	5.98E-10	9.97E-10	2.41E-10	4.80E-10	4.99E-10
Eating Fish	1	1.46E-09	1.46E-09	1.40E-09	2.33E-09	5.82E-10	1.16E-09	1.16E-09
Combined Routes of Exposure								
Hiker	1	4.67E-09	4.74E-09	5.14E-09	8.56E-09	1.49E-09	2.93E-09	4.28E-09
Berrypicker	1	1.51E-08	1.56E-08	1.87E-08	3.11E-08	3.66E-09	7.00E-09	1.56E-08
Hunter	1	6.87E-09	6.94E-09	7.33E-09	1.22E-08	2.33E-09	4.59E-09	6.10E-09
Fisherman	1	6.12E-09	6.19E-09	6.54E-09	1.09E-08	2.07E-09	4.09E-09	5.45E-09
Resident	1	1.47E-08	1.47E-08	1.47E-08	2.46E-08	5,49E-09	1.09E-08	1.23E-08
For 30 Exposures								
Dermal, Spray	30	3.04E-08	3.24E-08	4.86E-08	8.10E-08	9.72E-10	4.05E-10	4.05E-08
Vegetation Contact								
Hiker	30	4.36E-10	4.65E-10	6.97E-10	1.16E-09	1.39E-11	5.81E-12	5.81E-10
Picker	30	1.64E-07	1.75E-07	2.63E-07	4.38E-07	5.26E-09	2.19E-09	2.19E-07
Drinking Water	30	1.09E-07	1.09E-07	1.05E-07	1.75E-07	4.37E-08	8.74E-08	8.74E-08
Eating Berries	30	1.50E-07	1.50E-07	1.44E-07	2.40E-07	6.00E-08	1.20E-07	1.20E-07
Eating Vegets.	30	3.00E-07	3.00E-07	2.88E-07	4.80E-07	1.20E-07	2.40E-07	2.40E-07
Eating Deer	30	1.84E-08	1.84E-08	1.80E-08	2.99E-08	7.22E-09	1.44E-08	1.50E-08
Eating Fish	30	4.37E-08	4.37E-08	4.19E-08	6.99E-08	1.75E-08	3.49E-08	3.49E-08
Combined Routes of Exposure								
Hiker	30	1.40E-07	1.42E-07	1.54E-07	2.57E-07	4.47E-08	8.78E-08	1.28E-07
Berrypicker	30	4.54E-07	4.67E-07	5.60E-07	9.34E-07	1.10E-07	2.10E-07	4.67E-07
Hunter	30	2.06E-07	2.08E-07	2.20E-07	3.66E-07	6.98E-08	1.38E-07	1.83E-07
Fisherman	30	1.84E-07	1.86E-07	1.96E-07	3.27E-07	6.21E-08	1.23E-07	1.63E-07
Resident	30	4.40E-07	4.42E-07	4.42E-07	7.37E-07	1.65E-07	3.28E-07	3.69E-07

Table B-30

Lifetime Doses for Exposed Public (mg/kg/day)
Large Right of Way, Worst Case

	Exposures per Lifetime	Average Daily Dose for Exclusive Use of						
		2,4-D	2,4-DP	Asulam	Bromacil	Picloram	Amitrole	Glyphosate
For a Single Exposure								
Dermal, Spray	1	5.77E-09	7.51E-09	1.17E-08	2.35E-08	2.25E-10	1.88E-10	1.17E-08
Vegetation Contact								
Hiker	1	8.28E-11	1.08E-10	1.68E-10	3.37E-10	3.23E-12	2.69E-12	1.68E-10
Picker	1	1.49E-08	1.94E-08	3.02E-08	6.05E-08	5.81E-10	4.84E-10	3.02E-08
Drinking Water	1	7.99E-09	9.74E-09	9.74E-09	1.95E-08	3.90E-09	1.56E-08	9.74E-09
Eating Berries	1	1.24E-08	1.52E-08	1.52E-08	3.03E-08	6.07E-09	2.43E-08	1.52E-08
Eating Vegets.	1	2.49E-08	3.03E-08	3.03E-08	6.07E-08	1.21E-08	4.85E-08	3.03E-08
Eating Deer	1	1.55E-09	1.89E-09	1.92E-09	3.84E-09	7.39E-10	2.95E-09	1.92E-09
Eating Fish	1	3.20E-09	3.90E-09	3.90E-09	7.79E-09	1.56E-09	6.23E-09	3.90E-09
Combined Routes of Exposure								
Hiker	1	1.38E-08	1.74E-08	2.16E-08	4.33E-08	4.13E-09	1.58E-08	2.16E-08
Berrypicker	1	4.11E-08	5.18E-08	6.69E-08	1.34E-07	1.08E-08	4.05E-08	6.69E-08
Hunter	1	1.96E-08	2.44E-08	2.90E-08	5.79E-08	6.80E-09	2.64E-08	2.90E-08
Fisherman	1	1.70E-08	2.13E-08	2.55E-08	5.11E-08	5.68E-09	2.20E-08	2.55E-08
Resident	1	3.87E-08	4.77E-08	5.20E-08	1.04E-07	1.63E-08	6.43E-08	5.20E-08
For 30 Exposures								
Dermal, Spray	30	1.73E-07	2.25E-07	3.52E-07	7.04E-07	6.76E-09	5.63E-09	3.52E-07
Vegetation Contact								
Hiker	30	2.48E-09	3.23E-09	5.05E-09	1.01E-08	9.70E-11	8.08E-11	5.05E-09
Picker	30	4.46E-07	5.81E-07	9.07E-07	1.81E-06	1.74E-08	1.45E-08	9.07E-07
Drinking Water	30	2.40E-07	2.92E-07	2.92E-07	5.85E-07	1.17E-07	4.68E-07	2.92E-07
Eating Berries	30	3.73E-07	4.55E-07	4.55E-07	9.10E-07	1.82E-07	7.28E-07	4.55E-07
Eating Vegets.	30	7.46E-07	9.10E-07	9.10E-07	1.82E-06	3.64E-07	1.46E-06	9.10E-07
Eating Deer	30	4.65E-08	5.68E-08	5.76E-08	1.15E-07	2.22E-08	8.85E-08	5.76E-08
Eating Fish	30	9.59E-08	1.17E-07	1.17E-07	2.34E-07	4.68E-08	1.87E-07	1.17E-07
Combined Routes of Exposure								
Hiker	30	4.15E-07	5.21E-07	6.49E-07	1.30E-06	1.24E-07	4.73E-07	6.49E-07
Berrypicker	30	1.23E-06	1.55E-06	2.01E-06	4.01E-06	3.23E-07	1.22E-06	2.01E-06
Hunter	30	5.89E-07	7.33E-07	8.69E-07	1.74E-06	2.04E-07	7.93E-07	8.69E-07
Fisherman	30	5.11E-07	6.38E-07	7.66E-07	1.53E-06	1.71E-07	6.60E-07	7.66E-07
Resident	30	1.16E-06	1.43E-06	1.56E-06	3.12E-06	4.88E-07	1.93E-06	1.56E-06

LIFETIME DOSES FROM ACCIDENTAL-WORST CASE AND SPILLS

Table B-31

Lifetime Doses for Exposed Public (mg/kg/day)
Accidental Spraying

	Exposures per Lifetime	Average Daily Dose for Exclusive Use of						
		2,4-D	2,4-DP	Asulam	Bromacil	Picloram	Amitrole	Glyphosate
For a Single Exposure								
Dermal, Spray	1	4.02E-06	5.22E-06	8.16E-06	1.63E-05	3.92E-07	1.31E-07	8.16E-06
Vegetation Contact								
Hiker	1	5.76E-08	7.49E-08	1.17E-07	2.34E-07	5.62E-09	1.87E-09	1.17E-07
Picker	1	1.04E-05	1.35E-05	2.10E-05	4.21E-05	1.01E-06	3.37E-07	2.10E-05
Drinking Water	1	2.35E-06	2.87E-06	2.87E-06	5.74E-06	2.87E-06	4.59E-06	2.87E-06
Eating Berries	1	1.87E-06	2.28E-06	2.28E-06	4.56E-06	2.28E-06	3.65E-06	2.28E-06
Eating Vegets.	1	3.88E-06	4.73E-06	4.73E-06	9.47E-06	4.73E-06	7.57E-06	4.73E-06
Eating Deer	1	4.02E-07	4.92E-07	5.11E-07	1.02E-06	4.60E-07	7.34E-07	5.11E-07
Eating Fish	1	9.42E-07	1.15E-06	1.15E-06	2.30E-06	1.15E-06	1.84E-06	1.15E-06
Combined Routes of Exposure								
Hiker	1	6.43E-06	8.17E-06	1.12E-05	2.23E-05	3.27E-06	4.73E-06	1.12E-05
Berrypicker	1	1.86E-05	2.38E-05	3.44E-05	6.87E-05	6.55E-06	8.71E-06	3.44E-05
Hunter	1	9.35E-06	1.18E-05	1.49E-05	2.98E-05	6.58E-06	1.00E-05	1.49E-05
Fisherman	1	7.37E-06	9.32E-06	1.23E-05	2.46E-05	4.42E-06	6.56E-06	1.23E-05
Resident	1	1.03E-05	1.29E-05	1.59E-05	3.18E-05	8.00E-06	1.23E-05	1.59E-05
For 30 Exposures								
Dermal, Spray	30	1.20E-04	1.57E-04	2.45E-04	4.90E-04	1.18E-05	3.92E-06	2.45E-04
Vegetation Contact								
Hiker	30	1.73E-06	2.25E-06	3.51E-06	7.03E-06	1.69E-07	5.62E-08	3.51E-06
Picker	30	3.11E-04	4.04E-04	6.31E-04	1.26E-03	3.03E-05	1.01E-05	6.31E-04
Drinking Water	30	7.06E-05	8.61E-05	8.61E-05	1.72E-04	8.61E-05	1.38E-04	8.61E-05
Eating Berries	30	5.61E-05	6.84E-05	6.84E-05	1.37E-04	6.84E-05	1.09E-04	6.84E-05
Eating Vegets.	30	1.16E-04	1.42E-04	1.42E-04	2.84E-04	1.42E-04	2.27E-04	1.42E-04
Eating Deer	30	1.20E-05	1.48E-05	1.53E-05	3.07E-05	1.38E-05	2.20E-05	1.53E-05
Eating Fish	30	2.83E-05	3.45E-05	3.45E-05	6.89E-05	3.45E-05	5.51E-05	3.45E-05
Combined Routes of Exposure								
Hiker	30	1.93E-04	2.45E-04	3.35E-04	6.69E-04	9.81E-05	1.42E-04	3.35E-04
Berrypicker	30	5.58E-04	7.15E-04	1.03E-03	2.06E-03	1.97E-04	2.61E-04	1.03E-03
Hunter	30	2.81E-04	3.53E-04	4.47E-04	8.94E-04	1.98E-04	3.00E-04	4.47E-04
Fisherman	30	2.21E-04	2.80E-04	3.69E-04	7.38E-04	1.33E-04	1.97E-04	3.69E-04
Resident	30	3.09E-04	3.87E-04	4.77E-04	9.53E-04	2.40E-04	3.69E-04	4.77E-04

Table B-32

Lifetime Doses for Exposure Due to Spills (mg/kg/day)

	Exposures per Lifetime	Average Daily Dose for Exclusive Use of							
		2,4-D	2,4-DP	Asulam	Bromacil	Picloram	Amitrole	Glyphosate	Atrazine
For a Single Exposure									
Spills onto Skin									
Concentrate	1	5.64E-03	9.02E-03	9.39E-03	9.39E-03	2.25E-04	4.70E-05	7.05E-03	9.39E-03
Spray Mix	1	5.64E-04	3.76E-04	7.84E-04	4.70E-04	5.64E-05	9.39E-06	1.17E-03	9.39E-04
Spills into Water (1 Liter Drunk)									
Pond, Helo.	1	2.88E-06	-----	-----	-----	3.60E-06	-----	-----	2.88E-06
Reserv., Helo.	1	9.01E-08	-----	-----	-----	1.13E-07	-----	-----	9.01E-08
Pond, Truck	1	5.77E-05	3.60E-05	4.82E-05	2.88E-05	7.21E-05	5.77E-05	7.21E-05	5.77E-05
Reserv., Truck	1	1.80E-06	1.13E-06	1.50E-06	9.00E-07	2.25E-06	1.80E-06	2.25E-06	1.80E-06

ATTACHMENT C

MARGINS OF SAFETY FOR DOSES TO WORKERS AND THE PUBLIC CALCULATED IN THE RISK ANALYSIS

MARGINS OF SAFETY FOR DOSES TO WORKERS IN ROUTINE OPERATIONS

Table C-1

Margins of Safety for Workers Using Amitrole

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4080.0)	SYSTEMIC NOEL (0.03)	REPRODUCTIVE NOEL (5.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.0033	1000000+ [a]	7.6	1500
R-O-W SPRAYER	0.0001	1000000+	360	73000
R-O-W MIX/L	0.0001	1000000+	360	72000
R-O-W AP/M/L	0.0001	1000000+	260	52000
HACK & SQUIRT	0.0006	1000000+	45	9000
INJECTION BAR	0.0002	1000000+	120	24000
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.0310	130000	-1.2	160
R-O-W SPRAYER	0.0042	960000	5.9	1200
R-O-W MIX/L	0.0024	1000000+	10	2000
R-O-W AP/M/L	0.0029	1000000+	8.7	1700
HACK & SQUIRT	0.0063	650000	4.0	790
INJECTION BAR	0.0017	1000000+	15	3000

[a] The plus sign (+) means "greater than."

Table C-2

Margins of Safety for Workers Using Asulam

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (4000.0)	SYSTEMIC NOEL (50.00)	REPRODUCTIVE NOEL (50.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.1978	20000	250	250
R-O-W SPRAYER	0.0082	490000	6100	6100
R-O-W MIX/L	0.0084	480000	6000	6000
R-O-W AP/M/L	0.0116	350000	4300	4300
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	2.0693	1900	24	24
R-O-W SPRAYER	0.2652	15000	190	190
R-O-W MIX/L	0.1530	26000	330	330
R-O-W AP/M/L	0.1787	22000	280	280
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

Table C-3

Margins of Safety for Workers Using Atrazine

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1869.0)	SYSTEMIC NOEL (3.70)	REPRODUCTIVE NOEL (100.00)
Routine-Realistic Exposures				
PILOT	0.0755	25000	49	1300
MIXER/LOADER	0.1083	17000	34	920
SUPERVISOR	0.0116	160000	320	8700
OBSERVER	0.0025	760000	1500	41000
BACKPACK	0.4946	3800	7.5	200
R-O-W SPRAYER	0.0103	180000	360	9700
R-O-W MIX/L	0.0105	180000	350	9500
R-O-W AP/M/L	0.0145	130000	260	6900
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	0.6696	2800	5.5	150
MIXER/LOADER	0.8536	2200	4.3	120
SUPERVISOR	0.1160	16000	32	860
OBSERVER	0.0207	90000	180	4800
BACKPACK	2.4782	750	1.5	40
R-O-W SPRAYER	0.4509	4100	8.2	220
R-O-W MIX/L	0.2601	7200	14	380
R-O-W AP/M/L	0.3038	6200	12	330
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

Table C-4

Margins of Safety for Workers Using Bromacil

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD$_{50}$ (3998.0)	SYSTEMIC NOEL (6.25)	REPRODUCTIVE NOEL (7.92)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.6595	6100	9.5	12
R-O-W SPRAYER	0.0137	290000	460	580
R-O-W MIX/L	0.0140	290000	450	570
R-O-W AP/M/L	0.0193	210000	320	410
HACK & SQUIRT	0.1113	36000	56	71
INJECTION BAR	0.0424	94000	150	190
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	6.1955	650	1.0	1.3
R-O-W SPRAYER	0.5305	7500	12	15
R-O-W MIX/L	0.3060	13000	20	26
R-O-W AP/M/L	0.3574	11000	17	22
HACK & SQUIRT	1.2617	3200	5.0	6.3
INJECTION BAR	0.3373	12000	19	23

Table C-5

Margins of Safety for Workers Using 2,4-D

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (375.0)	SYSTEMIC NOEL (1.00)	REPRODUCTIVE NOEL (5.00)
Routine-Realistic Exposures				
PILOT	0.0302	12000	33	166
MIXER/LOADER	0.0433	8700	23	116
SUPERVISOR	0.0046	81000	220	1100
OBSERVER	0.0010	380000	1000	5200
BACKPACK	0.1978	1900	5.1	26
R-O-W SPRAYER	0.0051	73000	190	980
R-O-W MIX/L	0.0052	72000	190	960
R-O-W AP/M/L	0.0072	52000	140	700
HACK & SQUIRT	0.0668	5600	15	74
INJECTION BAR	0.0254	15000	39	200
Routine-Worst Case Exposures				
PILOT	0.4018	930	2.5	12
MIXER/LOADER	0.5122	730	2.0	10
SUPERVISOR	0.0696	5400	14	72
OBSERVER	0.0124	30000	81	500
BACKPACK	1.4869	250	-1.5	3.4
R-O-W SPRAYER	0.1305	2900	7.7	38
R-O-W MIX/L	0.0753	5000	13	66
R-O-W AP/M/L	0.0879	4300	11	56
HACK & SQUIRT	0.7570	500	1.3	6.6
INJECTION BAR	0.2024	1900	4.9	24

Table C-6

Margins of Safety for Workers Using 2,4-DP

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (532.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (6.25)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.2110	2500	24	30
R-O-W SPRAYER	0.0055	97000	910	1100
R-O-W MIX/L	0.0056	95000	890	1100
R-O-W AP/M/L	0.0077	69000	650	810
HACK & SQUIRT	0.1069	5000	47	58
INJECTION BAR	0.0407	13000	120	150
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	1.7050	310	2.9	3.7
R-O-W SPRAYER	0.1698	3100	29	37
R-O-W MIX/L	0.0979	5400	51	64
R-O-W AP/M/L	0.1144	4700	44	55
HACK & SQUIRT	1.2112	440	4.1	5.2
INJECTION BAR	0.3238	1600	15	19

Table C-7

Margins of Safety for Workers Using Dalapon

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (7577.0)	SYSTEMIC NOEL (15.00)	REPRODUCTIVE NOEL (300.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.6595	11000	23	450
R-O-W SPRAYER	0.0137	550000	1100	22000
R-O-W MIX/L	0.0140	540000	1100	21000
R-O-W AP/M/L	0.0193	390000	780	16000
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	7.4346	1000	2.0	40
R-O-W SPRAYER	0.5305	14000	28	570
R-O-W MIX/L	0.3060	25000	49	980
R-O-W AP/M/L	0.3574	21000	42	840
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

Table C-8

Margins of Safety for Workers Using Dicamba

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (757.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (2.50)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.0412	18000	610	61
R-O-W SPRAYER	0.0017	440000	15000	1500
R-O-W MIX/L	0.0017	430000	14000	1400
R-O-W AP/M/L	0.0024	310000	10000	1000
HACK & SQUIRT	0.0557	14000	450	45
INJECTION BAR	0.0212	36000	1200	120
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	1.2391	610	20	2.0
R-O-W SPRAYER	0.0955	7900	260	26
R-O-W MIX/L	0.0551	14000	450	45
R-O-W AP/M/L	0.0643	12000	390	39
HACK & SQUIRT	0.6308	1200	40	4.0
INJECTION BAR	0.1686	4500	150	15

Table C-9

Margins of Safety for Workers Using Diuron

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD$_{50}$ (3750.0)	SYSTEMIC NOEL (0.63)	REPRODUCTIVE NOEL (6.25)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.6595	5700	-1.1	9.5
R-O-W SPRAYER	0.0137	270000	46	460
R-O-W MIX/L	0.0140	270000	45	450
R-O-W AP/M/L	0.0193	190000	32	320
HACK & SQUIRT	0.1113	34000	5.6	56
INJECTION BAR	0.0424	89000	15	150
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	3.7173	1000	-5.9	1.7
R-O-W SPRAYER	0.8488	4400	-1.4	7.4
R-O-W MIX/L	0.4896	7700	1.3	13
R-O-W AP/M/L	0.5719	6600	1.1	11
HACK & SQUIRT	1.2617	3000	-2.0	5.0
INJECTION BAR	0.3373	11000	1.9	19

Table C-10

Margins of Safety for Workers Using Fosamine

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (24400.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (500.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.4946	49000	51	1000
R-O-W SPRAYER	0.0137	1000000+ [a]	1800	37000
R-O-W MIX/L	0.0140	1000000+	1800	36000
R-O-W AP/M/L	0.0193	1000000+	1300	26000
HACK & SQUIRT	0.1113	220000	220	4500
INJECTION BAR	0.0424	580000	590	12000
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	7.1248	3400	3.5	73
R-O-W SPRAYER	0.5676	43000	44	870
R-O-W MIX/L	0.3274	75000	76	1500
R-O-W AP/M/L	0.3824	64000	65	1300
HACK & SQUIRT	1.2617	19000	20	390
INJECTION BAR	0.3373	72000	74	1500

[a] The plus sign (+) means "greater than."

Table C-11

Margins of Safety for Workers Using Glyphosate

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4320.0)	SYSTEMIC NOEL (31.0)	REPRODUCTIVE NOEL (10.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.2473	17000	130	40
R-O-W SPRAYER	0.0069	630000	4600	1500
R-O-W MIX/L	0.0070	620000	4500	1400
R-O-W AP/M/L	0.0096	450000	3200	1000
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	3.0978	1400	10	3.2
R-O-W SPRAYER	0.2652	16000	120	38
R-O-W MIX/L	0.1530	28000	210	65
R-O-W AP/M/L	0.1787	24000	180	56
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

Table C-12

Margins of Safety for Workers Using Hexazinone

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1690.0)	SYSTEMIC NOEL (10.00)	REPRODUCTIVE NOEL (125.00)
Routine-Realistic Exposures				
PILOT	0.0504	34000	200	2500
MIXER/LOADER	0.0722	23000	140	1700
SUPERVISOR	0.0077	220000	1300	16000
OBSERVER	0.0016	1000000	6100	77000
BACKPACK	0.1846	9200	54	680
R-O-W SPRAYER	0.0086	200000	1200	15000
R-O-W MIX/L	0.0087	190000	1100	14000
R-O-W AP/M/L	0.0120	140000	830	10000
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	0.5022	3400	20	250
MIXER/LOADER	0.6402	2600	16	200
SUPERVISOR	0.0870	19000	110	1400
OBSERVER	0.0155	110000	650	8100
BACKPACK	1.8587	910	5.4	67
R-O-W SPRAYER	0.3183	5300	31	390
R-O-W MIX/L	0.1836	9200	54	680
R-O-W AP/M/L	0.2145	7900	47	580
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

Table C-13

Margins of Safety for Workers Using Picloram

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (8200.0)	SYSTEMIC NOEL (7.00)	REPRODUCTIVE NOEL (50.00)
Routine-Realistic Exposures				
PILOT	0.0010	1000000+ [a]	7200	52000
MIXER/LOADER	0.0014	1000000+	5000	36000
SUPERVISOR	0.0001	1000000+	47000	340000
OBSERVER	0.0000	1000000+	220000	1000000+
BACKPACK	0.0079	1000000	880	6300
R-O-W SPRAYER	0.0002	1000000+	43000	300000
R-O-W MIX/L	0.0002	1000000+	42000	300000
R-O-W AP/M/L	0.0002	1000000+	30000	220000
HACK & SQUIRT	0.0027	1000000+	2600	19000
INJECTION BAR	0.0010	1000000+	6900	49000
Routine-Worst Case Exposures				
PILOT	0.0402	200000	170	1200
MIXER/LOADER	0.0512	160000	140	980
SUPERVISOR	0.0070	1000000+	1000	7200
OBSERVER	0.0012	1000000+	5600	40000
BACKPACK	0.1190	69000	59	420
R-O-W SPRAYER	0.0051	1000000+	1400	9800
R-O-W MIX/L	0.0029	1000000+	2400	17000
R-O-W AP/M/L	0.0034	1000000+	2000	15000
HACK & SQUIRT	0.0303	270000	230	1700
INJECTION BAR	0.0081	1000000	860	6200

[a] The plus sign (+) means "greater than."

Table C-14

Margins of Safety for Workers Using Simazine

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (5000.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (5.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.3297	15000	15	15
R-O-W SPRAYER	0.0069	730000	730	730
R-O-W MIX/L	0.0070	720000	720	720
R-O-W AP/M/L	0.0096	520000	520	520
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	2.8499	1800	1.8	1.8
R-O-W SPRAYER	0.2440	20000	20	20
R-O-W MIX/L	0.1408	36000	36	36
R-O-W AP/M/L	0.1644	30000	30	30
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

Table C-15

Margins of Safety for Workers Using Tebuthiuron

	EXPOSURE (MG/KG/DAY)	LD_{50} (644.0)	SYSTEMIC NOEL (12.50)	REPRODUCTIVE NOEL (90.00)
		MARGIN OF SAFETY RELATIVE TO		
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.2473	2600	51	360
R-O-W SPRAYER	0.0075	85000	1700	12000
R-O-W MIX/L	0.0077	84000	1600	12000
R-O-W AP/M/L	0.0106	61000	1200	8500
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	3.7173	170	3.4	24
R-O-W SPRAYER	0.2440	2600	51	370
R-O-W MIX/L	0.1408	4600	89	640
R-O-W AP/M/L	0.1644	3900	76	550
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

Table C-16

Margins of Safety for Workers Using Triclopyr

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (630.0)	SYSTEMIC NOEL (2.50)	REPRODUCTIVE NOEL (10.00)
Routine-Realistic Exposures				
PILOT	0.0403	16000	62	250
MIXER/LOADER	0.0578	11000	43	170
SUPERVISOR	0.0062	100000	410	1600
OBSERVER	0.0013	480000	1900	7700
BACKPACK	0.3297	1900	7.6	30
R-O-W SPRAYER	0.0069	92000	360	1500
R-O-W MIX/L	0.0070	90000	360	1400
R-O-W AP/M/L	0.0096	65000	260	1000
HACK & SQUIRT	0.1113	5700	22	90
INJECTION BAR	0.0424	15000	59	240
Routine-Worst Case Exposures				
PILOT	1.3392	470	1.9	7.5
MIXER/LOADER	1.7072	370	1.5	5.9
SUPERVISOR	0.2320	2700	11	43
OBSERVER	0.0413	15000	60	240
BACKPACK	4.9564	130	-2.0	2.0
R-O-W SPRAYER	0.4244	1500	5.9	24
R-O-W MIX/L	0.2448	2600	10	41
R-O-W AP/M/L	0.2859	2200	8.7	35
HACK & SQUIRT	1.2617	500	2.0	7.9
INJECTION BAR	0.3373	1900	7.4	30

MARGINS OF SAFETY FOR DOSES TO WORKERS WEARING PROTECTIVE CLOTHING IN ROUTINE OPERATIONS

Table C-17

Margins of Safety for Workers Wearing Protective Clothing and Using Amitrole

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4080.0)	SYSTEMIC NOEL (0.03)	REPRODUCTIVE NOEL (5.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.0010	1000000+ [a]	24	4900
R-O-W SPRAYER	0.0000	1000000+	1200	230000
R-O-W MIX/L	0.0001	1000000+	490	98000
R-O-W AP/M/L	0.0001	1000000+	500	100000
HACK & SQUIRT	0.0002	1000000+	110	21000
INJECTION BAR	0.0001	1000000+	260	52000
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.0097	420000	2.6	520
R-O-W SPRAYER	0.0013	1000000+	19	3800
R-O-W MIX/L	0.0018	1000000+	14	2800
R-O-W AP/M/L	0.0015	1000000+	17	3400
HACK & SQUIRT	0.0027	1000000+	9.3	1900
INJECTION BAR	0.0008	1000000+	33	6500

[a] The plus sign (+) means "greater than."

Table C-18

Margins of Safety for Workers Wearing Protective Clothing and Using Asulam

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4000.0)	SYSTEMIC NOEL (50.00)	REPRODUCTIVE NOEL (50.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.0617	65000	970	810
R-O-W SPRAYER	0.0026	1000000+ [a]	23000	19000
R-O-W MIX/L	0.0061	650000	9800	8200
R-O-W AP/M/L	0.0060	660000	10000	8300
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.6456	6200	93	77
R-O-W SPRAYER	0.0828	48000	730	600
R-O-W MIX/L	0.1115	36000	540	450
R-O-W AP/M/L	0.0930	43000	650	540
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

[a] The plus sign (+) means "greater than."

Table C-19

Margins of Safety for Workers Wearing Protective Clothing and Using Atrazine

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1869.0)	SYSTEMIC NOEL (3.70)	REPRODUCTIVE NOEL (100.00)
Routine-Realistic Exposures				
PILOT	0.0317	59000	120	3200
MIXER/LOADER	0.0790	24000	47	1300
SUPERVISOR	0.0048	390000	760	21000
OBSERVER	0.0010	1000000+ [a]	3600	97000
BACKPACK	0.1543	12000	24	650
R-O-W SPRAYER	0.0032	580000	1200	31000
R-O-W MIX/L	0.0076	240000	480	13000
R-O-W AP/M/L	0.0075	250000	490	13000
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	0.2806	6700	13	360
MIXER/LOADER	0.6223	3000	5.9	160
SUPERVISOR	0.0486	38000	76	2100
OBSERVER	0.0087	220000	430	12000
BACKPACK	0.7732	2400	4.8	130
R-O-W SPRAYER	0.1407	13000	26	710
R-O-W MIX/L	0.1896	9900	20	530
R-O-W AP/M/L	0.1581	12000	23	630
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

[a] The plus sign (+) means "greater than."

Table C-20

Margins of Safety for Workers Wearing Protective Clothing and Using Bromacil

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (3998.0)	SYSTEMIC NOEL (6.25)	REPRODUCTIVE NOEL (7.92)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.2057	19000	30	38
R-O-W SPRAYER	0.0043	930000	1500	1900
R-O-W MIX/L	0.0102	390000	610	780
R-O-W AP/M/L	0.0100	400000	620	790
HACK & SQUIRT	0.0472	85000	130	170
INJECTION BAR	0.0192	210000	330	410
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	1.9330	2100	3.2	4.1
R-O-W SPRAYER	0.1655	24000	38	48
R-O-W MIX/L	0.2231	18000	28	36
R-O-W AP/M/L	0.1860	21000	34	43
HACK & SQUIRT	0.5350	7500	12	15
INJECTION BAR	0.1528	26000	41	52

Table C-21

Margins of Safety for Workers Wearing Protective Clothing and Using 2,4-D

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD$_{50}$ (375.0)	SYSTEMIC NOEL (1.00)	REPRODUCTIVE NOEL (5.00)
Routine-Realistic Exposures				
PILOT	0.0127	30000	79	400
MIXER/LOADER	0.0316	12000	32	160
SUPERVISOR	0.0019	190000	520	2600
OBSERVER	0.0004	910000	2400	12000
BACKPACK	0.0617	6100	16	82
R-O-W SPRAYER	0.0016	230000	620	3200
R-O-W MIX/L	0.0038	98000	260	1300
R-O-W AP/M/L	0.0038	100000	270	1300
HACK & SQUIRT	0.0283	13000	35	180
INJECTION BAR	0.0115	33000	87	440
Routine-Worst Case Exposures				
PILOT	0.1683	2200	5.9	30
MIXER/LOADER	0.3734	1000	2.7	13
SUPERVISOR	0.0292	13000	34	170
OBSERVER	0.0052	72000	190	960
BACKPACK	0.4639	810	2.2	11
R-O-W SPRAYER	0.0407	9200	25	120
R-O-W MIX/L	0.0549	6800	18	92
R-O-W AP/M/L	0.0458	8200	22	110
HACK & SQUIRT	0.3210	1200	3.1	16
INJECTION BAR	0.0917	4100	11	54

Table C-22

Margins of Safety for Workers Wearing Protective Clothing and Using 2,4-DP

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD$_{50}$ (532.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (6.25)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.0658	8100	76	95
R-O-W SPRAYER	0.0017	310000	2900	3700
R-O-W MIX/L	0.0041	130000	1200	1500
R-O-W AP/M/L	0.0040	130000	1200	1600
HACK & SQUIRT	0.0453	12000	110	140
INJECTION BAR	0.0184	29000	270	340
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.5320	1000	9.4	12
R-O-W SPRAYER	0.0530	10000	94	120
R-O-W MIX/L	0.0714	7500	70	88
R-O-W AP/M/L	0.0595	8900	84	100
HACK & SQUIRT	0.5136	1000	9.7	12
INJECTION BAR	0.1467	3600	34	43

Table C-23

Margins of Safety for Workers Wearing Protective Clothing and Using Dalapon

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (7577.0)	SYSTEMIC NOEL (15.00)	REPRODUCTIVE NOEL (300.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.2057	37000	73	1500
R-O-W SPRAYER	0.0043	1000000+ [a]	3500	70000
R-O-W MIX/L	0.0102	740000	1500	29000
R-O-W AP/M/L	0.0100	760000	1500	30000
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	2.3196	3300	6.5	130
R-O-W SPRAYER	0.1655	46000	91	1800
R-O-W MIX/L	0.2231	34000	67	1300
R-O-W AP/M/L	0.1860	41000	81	1600
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

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[a] The plus sign (+) means "greater than."

Table C-24

Margins of Safety for Workers Wearing Protective Clothing and Using Dicamba

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (757.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (2.50)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.0129	59000	1900	190
R-O-W SPRAYER	0.0005	1000000+ [a]	47000	4700
R-O-W MIX/L	0.0013	590000	20000	2000
R-O-W AP/M/L	0.0013	600000	20000	2000
HACK & SQUIRT	0.0236	32000	1100	110
INJECTION BAR	0.0096	79000	2600	260
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.3866	2000	65	6.5
R-O-W SPRAYER	0.0298	25000	840	84
R-O-W MIX/L	0.0402	19000	620	62
R-O-W AP/M/L	0.0335	23000	750	75
HACK & SQUIRT	0.2675	2800	93	9.3
INJECTION BAR	0.0764	9900	330	33

[a] The plus sign (+) means "greater than."

Table C-25

Margins of Safety for Workers Wearing Protective Clothing and Using Diuron

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (3750.0)	SYSTEMIC NOEL (0.63)	REPRODUCTIVE NOEL (6.25)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.2057	18000	3.0	30
R-O-W SPRAYER	0.0043	880000	150	1500
R-O-W MIX/L	0.0102	370000	61	610
R-O-W AP/M/L	0.0100	370000	62	620
HACK & SQUIRT	0.0472	79000	13	130
INJECTION BAR	0.0192	200000	33	330
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	1.1598	3200	-1.9	5.4
R-O-W SPRAYER	0.2648	14000	2.4	24
R-O-W MIX/L	0.3569	11000	1.8	18
R-O-W AP/M/L	0.2977	13000	2.1	21
HACK & SQUIRT	0.5350	7000	1.2	12
INJECTION BAR	0.1528	25000	4.1	41

Table C-26

Margins of Safety for Workers Wearing Protective Clothing and Using Fosamine

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (24400.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (500.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.1543	160000	160	3300
R-O-W SPRAYER	0.0043	1000000+ [a]	5800	120000
R-O-W MIX/L	0.0102	1000000+	2500	49000
R-O-W AP/M/L	0.0100	1000000+	2500	50000
HACK & SQUIRT	0.0472	520000	530	11000
INJECTION BAR	0.0192	1000000+	1300	26000
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	2.2229	11000	11	230
R-O-W SPRAYER	0.1771	140000	140	2800
R-O-W MIX/L	0.2387	100000	100	2100
R-O-W AP/M/L	0.1991	120000	130	2500
HACK & SQUIRT	0.5350	46000	47	930
INJECTION BAR	0.1528	160000	160	3300

[a] The plus sign (+) means "greater than."

Table C-27

Margins of Safety for Workers Wearing Protective Clothing and Using Glyphosate

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4320.0)	SYSTEMIC NOEL (31.0)	REPRODUCTIVE NOEL (10.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.0772	56000	410	130
R-O-W SPRAYER	0.0021	1000000+ [a]	15000	4700
R-O-W MIX/L	0.0051	850000	6100	2000
R-O-W AP/M/L	0.0050	860000	6200	2000
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.9665	4500	32	10
R-O-W SPRAYER	0.0828	52000	370	120
R-O-W MIX/L	0.1115	39000	280	90
R-O-W AP/M/L	0.0930	46000	330	110
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

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[a] The plus sign (+) means "greater than."

Table C-28

Margins of Safety for Workers Wearing Protective Clothing and Using Hexazinone

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO		
		LD$_{50}$ (1690.0)	SYSTEMIC NOEL (10.00)	REPRODUCTIVE NOEL (125.00)
Routine-Realistic Exposures				
PILOT	0.0211	80000	470	5900
MIXER/LOADER	0.0526	32000	190	2400
SUPERVISOR	0.0032	520000	3100	39000
OBSERVER	0.0007	1000000+ [a]	15000	180000
BACKPACK	0.0576	29000	170	2200
R-O-W SPRAYER	0.0027	630000	3700	47000
R-O-W MIX/L	0.0064	270000	1600	20000
R-O-W AP/M/L	0.0063	270000	1600	20000
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	0.2104	8000	48	590
MIXER/LOADER	0.4667	3600	21	270
SUPERVISOR	0.0365	46000	270	3400
OBSERVER	0.0065	260000	1500	19000
BACKPACK	0.5799	2900	17	220
R-O-W SPRAYER	0.0993	17000	100	1300
R-O-W MIX/L	0.1338	13000	75	930
R-O-W AP/M/L	0.1116	15000	90	1100
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

[a] The plus sign (+) means "greater than."

Table C-29

Margins of Safety for Workers Wearing Protective Clothing and Using Picloram

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD$_{50}$ (8200.0)	SYSTEMIC NOEL (7.00)	REPRODUCTIVE NOEL (50.00)
Routine-Realistic Exposures				
PILOT	0.0004	1000000+ [a]	17000	120000
MIXER/LOADER	0.0010	1000000+	6900	49000
SUPERVISOR	0.0001	1000000+	110000	810000
OBSERVER	0.0000	1000000+	530000	1000000+
BACKPACK	0.0025	1000000+	2800	20000
R-O-W SPRAYER	0.0001	1000000+	140000	970000
R-O-W MIX/L	0.0001	1000000+	57000	410000
R-O-W AP/M/L	0.0001	1000000+	58000	420000
HACK & SQUIRT	0.0011	1000000+	6200	44000
INJECTION BAR	0.0005	1000000+	15000	110000
Routine-Worst Case Exposures				
PILOT	0.0168	490000	420	3000
MIXER/LOADER	0.0373	220000	190	1300
SUPERVISOR	0.0029	1000000+	2400	17000
OBSERVER	0.0005	1000000+	13000	96000
BACKPACK	0.0371	220000	190	1300
R-O-W SPRAYER	0.0016	1000000+	4400	31000
R-O-W MIX/L	0.0021	1000000+	3300	23000
R-O-W AP/M/L	0.0018	1000000+	3900	28000
HACK & SQUIRT	0.0128	640000	550	3900
INJECTION BAR	0.0037	1000000+	1900	14000

[a] The plus sign (+) means "greater than."

Table C-30

Margins of Safety for Workers Wearing Protective Clothing and Using Simazine

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (5000.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (5.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.1029	49000	49	49
R-O-W SPRAYER	0.0021	1000000+ [a]	2300	2300
R-O-W MIX/L	0.0051	980000	980	980
R-O-W AP/M/L	0.0050	1000000	1000	1000
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	0.3507	14000	14	14
MIXER/LOADER	0.7778	6400	6.4	6.4
SUPERVISOR	0.0608	82000	82	82
OBSERVER	0.0108	460000	460	460
BACKPACK	0.8892	5600	5.6	5.6
R-O-W SPRAYER	0.0761	66000	66	66
R-O-W MIX/L	0.1026	49000	49	49
R-O-W AP/M/L	0.0856	58000	58	58
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

[a] The plus sign (+) means "greater than."

Table C-31

Margins of Safety for Workers Wearing Protective Clothing and Using Tebuthiuron

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (644.0)	SYSTEMIC NOEL (12.50)	REPRODUCTIVE NOEL (90.00)
Routine-Realistic Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	0.0772	8300	160	1200
R-O-W SPRAYER	0.0024	270000	5300	38000
R-O-W MIX/L	0.0056	110000	2200	16000
R-O-W AP/M/L	0.0055	120000	2300	16000
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---
Routine-Worst Case Exposures				
PILOT	---	---	---	---
MIXER/LOADER	---	---	---	---
SUPERVISOR	---	---	---	---
OBSERVER	---	---	---	---
BACKPACK	1.1598	560	11	78
R-O-W SPRAYER	0.0761	8500	160	1200
R-O-W MIX/L	0.1026	6300	120	880
R-O-W AP/M/L	0.0856	7500	150	1100
HACK & SQUIRT	---	---	---	---
INJECTION BAR	---	---	---	---

Table C-32

Margins of Safety for Workers Wearing Protective Clothing and Using Triclopyr

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (630.0)	SYSTEMIC NOEL (2.50)	REPRODUCTIVE NOEL (10.00)
Routine-Realistic Exposures				
PILOT	0.0169	37000	150	590
MIXER/LOADER	0.0421	15000	59	240
SUPERVISOR	0.0026	240000	970	3900
OBSERVER	0.0005	1000000+ [a]	4600	18000
BACKPACK	0.1029	6100	24	97
R-O-W SPRAYER	0.0021	290000	1200	4700
R-O-W MIX/L	0.0051	120000	490	2000
R-O-W AP/M/L	0.0050	130000	500	2000
HACK & SQUIRT	0.0472	13000	53	210
INJECTION BAR	0.0192	33000	130	520
Routine-Worst Case Exposures				
PILOT	0.5611	1100	4.5	18
MIXER/LOADER	1.2445	510	2.0	8.0
SUPERVISOR	0.0972	6500	26	100
OBSERVER	0.0173	36000	140	580
BACKPACK	1.5464	410	1.6	6.5
R-O-W SPRAYER	0.1324	4800	19	76
R-O-W MIX/L	0.1784	3500	14	56
R-O-W AP/M/L	0.1488	4200	17	67
HACK & SQUIRT	0.5350	1200	4.7	19
INJECTION BAR	0.1528	4100	16	65

[a] The plus sign (+) means "greater than."

MARGINS OF SAFETY FOR DOSES TO THE PUBLIC FROM ROUTINE OPERATIONS

Table C-33

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Amitrole Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4080.0)	SYSTEMIC NOEL (0.03)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+ [a]	14000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	980000	1000000+
PICKER	0.0000	1000000+	3500	710000
DRINKING WATER	0.0002	1000000+	150	30000
EATING BERRIES	0.0003	1000000+	82	16000
EATING VEGETS.	0.0006	1000000+	41	8200
EATING DEER	0.0000	1000000+	660	130000
EATING BIRD	0.0001	1000000+	230	46000
EATING FISH	0.0001	1000000+	380	75000
For Combined Routes of Exposure:				
HIKER	0.0002	1000000+	150	30000
BERRYPICKER	0.0005	1000000+	52	10000
HUNTER	0.0003	1000000+	79	16000
FISHERMAN	0.0002	1000000+	110	21000
RESIDENT	0.0008	1000000+	32	6400

[a] The plus sign (+) means "greater than."

Table C-34

Margins of Safety for Exposed Members of the Public Right-of-Way Routine-Realistic Scenario Amitrole Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4080.0)	SYSTEMIC NOEL (0.03)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+ [a]	72000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0000	1000000+	13000	1000000+
DRINKING WATER	0.0001	1000000+	340	67000
EATING BERRIES	0.0001	1000000+	240	49000
EATING VEGETS.	0.0002	1000000+	120	24000
EATING DEER	0.0000	1000000+	2000	410000
EATING BIRD	0.0000	1000000+	820	60000
EATING FISH	0.0000	1000000+	840	170000
For Combined Routes of Exposure				
HIKER	0.0001	1000000+	330	67000
BERRYPICKER	0.0002	1000000+	140	28000
HUNTER	0.0001	1000000+	210	43000
FISHERMAN	0.0001	1000000+	240	48000
RESIDENT	0.0003	1000000+	90	18000

[a] The plus sign (+) means "greater than."

Table C-35

Margins of Safety for Exposed Members of the Public Backpack Routine-Worst Case Scenario Amitrole Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4080.0)	SYSTEMIC NOEL (0.03)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	2900	580000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	200000	1000000+
PICKER	0.0000	1000000+	1100	230000
DRINKING WATER	0.0005	1000000+	52	10000
EATING BERRIES	0.0009	1000000+	27	5400
EATING VEGETS.	0.0018	1000000+	14	2700
EATING DEER	0.0001	1000000+	220	43000
EATING BIRD	0.0003	1000000+	74	15000
EATING FISH	0.0002	1000000+	130	26000
For Combined Routes of Exposure				
HIKER	0.0005	1000000+	51	10000
BERRYPICKER	0.0014	1000000+	17	3500
HUNTER	0.0009	1000000+	27	5300
FISHERMAN	0.0007	1000000+	37	7400
RESIDENT	0.0023	1000000+	11	2100

[a] The plus sign (+) means "greater than."

Table C-36

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Amitrole Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4080.0)	SYSTEMIC NOEL (0.03)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	5200	1000000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	360000	1000000+
PICKER	0.0000	1000000+	2000	400000
DRINKING WATER	0.0004	1000000+	63	13000
EATING BERRIES	0.0006	1000000+	40	8100
EATING VEGETS.	0.0012	1000000+	20	4000
EATING DEER	0.0001	1000000+	330	66000
EATING BIRD	0.0002	1000000+	130	25000
EATING FISH	0.0002	1000000+	160	31000
For Combined Routes of Exposure				
HIKER	0.0004	1000000+	62	12000
BERRYPICKER	0.0010	1000000+	24	4800
HUNTER	0.0007	1000000+	37	7400
FISHERMAN	0.0006	1000000+	44	8900
RESIDENT	0.0016	1000000+	15	3000

[a] The plus sign (+) means "greater than."

Table C-37

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Asulam Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4000.0)	SYSTEMIC NOEL (50.00)	REPRODUCTIVE NOEL (50.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	470000	470000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0004	1000000+	120000	120000
DRINKING WATER	0.0001	1000000+	500000	500000
EATING BERRIES	0.0002	1000000+	270000	270000
EATING VEGETS.	0.0004	1000000+	140000	140000
EATING DEER	0.0000	1000000+	1000000+	1000000+
EATING BIRD	0.0001	1000000+	680000	680000
EATING FISH	0.0000	1000000+	1000000+	1000000+
For Combined Routes of Exposure				
HIKER	0.0002	1000000+	240000	240000
BERRYPICKER	0.0008	1000000+	62000	62000
HUNTER	0.0003	1000000+	160000	160000
FISHERMAN	0.0002	1000000+	200000	200000
RESIDENT	0.0006	1000000+	87000	87000

[a] The plus sign (+) means "greater than."

Table C-38

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
Asulam Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4000.0)	SYSTEMIC NOEL (50.00)	REPRODUCTIVE NOEL (50.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	1000000+	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0002	1000000+	220000	220000
DRINKING WATER	0.0001	1000000+	560000	560000
EATING BERRIES	0.0001	1000000+	410000	410000
EATING VEGETS.	0.0002	1000000+	200000	200000
EATING DEER	0.0000	1000000+	1000000+	1000000+
EATING BIRD	0.0000	1000000+	1000000+	1000000+
EATING FISH	0.0000	1000000+	1000000+	1000000+
For Combined Routes of Exposure				
HIKER	0.0001	1000000+	380000	380000
BERRYPICKER	0.0005	1000000+	100000	100000
HUNTER	0.0002	1000000+	270000	270000
FISHERMAN	0.0002	1000000+	300000	300000
RESIDENT	0.0004	1000000+	130000	130000

[a] The plus sign (+) means "greater than."

Table C-39

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Asulam Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4000.0)	SYSTEMIC NOEL (50.00)	REPRODUCTIVE NOEL (50.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0006	1000000+[a]	87000	87000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0015	1000000+	34000	34000
DRINKING WATER	0.0003	1000000+	160000	160000
EATING BERRIES	0.0006	1000000+	81000	81000
EATING VEGETS.	0.0012	1000000+	41000	41000
EATING DEER	0.0001	1000000+	620000	620000
EATING BIRD	0.0003	1000000+	200000	200000
EATING FISH	0.0001	1000000+	390000	390000
For Combined Routes of Exposure				
HIKER	0.0009	1000000+	56000	56000
BERRYPICKER	0.0030	1000000+	17000	17000
HUNTER	0.0012	1000000+	40000	40000
FISHERMAN	0.0010	1000000+	49000	49000
RESIDENT	0.0021	1000000+	23000	23000

[a] The plus sign (+) means "greater than."

Table C-40

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Asulam Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4000.0)	SYSTEMIC NOEL (50.00)	REPRODUCTIVE NOEL (50.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0003	1000000+[a]	170000	170000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0008	1000000+	65000	65000
DRINKING WATER	0.0002	1000000+	200000	200000
EATING BERRIES	0.0004	1000000+	130000	130000
EATING VEGETS.	0.0008	1000000+	64000	64000
EATING DEER	0.0000	1000000+	1000000+	1000000+
EATING BIRD	0.0001	1000000+	360000	360000
EATING FISH	0.0001	1000000+	500000	500000
For Combined Routes of Exposure				
HIKER	0.0006	1000000+	90000	90000
BERRYPICKER	0.0017	1000000+	29000	29000
HUNTER	0.0007	1000000+	68000	68000
FISHERMAN	0.0007	1000000+	77000	77000
RESIDENT	0.0013	1000000+	38000	38000

[a] The plus sign (+) means "greater than."

Table C-41

Margins of Safety for Exposed Members of the Public
Aerial Routine-Realistic Scenario
Atrazine Sprayed on 40 acres by Helicopter

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1869.0)	SYSTEMIC NOEL (3.70)	REPRODUCTIVE NOEL (100.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	120000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0061	310000	610	16000
DRINKING WATER	0.0035	530000	1000	28000
EATING BERRIES	0.0020	920000	1800	49000
EATING VEGETS.	0.0040	460000	910	25000
EATING DEER	0.0003	1000000+	13000	350000
EATING BIRD	0.0010	1000000+	3600	97000
EATING FISH	0.0071	260000	520	14000
For Combined Routes of Exposure				
HIKER	0.0036	520000	1000	28000
BERRYPICKER	0.0117	160000	320	8600
HUNTER	0.0049	380000	760	20000
FISHERMAN	0.0106	180000	350	9400
RESIDENT	0.0076	250000	490	13000

[a] The plus sign (+) means "greater than."

Table C-42

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Atrazine Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1869.0)	SYSTEMIC NOEL (3.70)	REPRODUCTIVE NOEL (100.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0003	1000000+[a]	14000	370000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	970000	1000000+
PICKER	0.0011	1000000+	3500	95000
DRINKING WATER	0.0002	1000000+	15000	400000
EATING BERRIES	0.0005	1000000+	8100	220000
EATING VEGETS.	0.0009	1000000+	4000	110000
EATING DEER	0.0001	1000000+	62000	1000000+
EATING BIRD	0.0002	1000000+	20000	540000
EATING FISH	0.0005	1000000+	7400	200000
For Combined Routes of Exposure				
HIKER	0.0005	1000000+	7100	190000
BERRYPICKER	0.0020	920000	1800	49000
HUNTER	0.0008	1000000+	4800	130000
FISHERMAN	0.0010	1000000+	3600	98000
RESIDENT	0.0014	1000000+	2600	70000

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[a] The plus sign (+) means "greater than."

Table C-43

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
Atrazine Sprayed on 12 acres

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (1869.0)	SYSTEMIC NOEL (3.70)	REPRODUCTIVE NOEL (100.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	72000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0003	1000000+	13000	360000
DRINKING WATER	0.0001	1000000+	33000	900000
EATING BERRIES	0.0002	1000000+	24000	650000
EATING VEGETS.	0.0003	1000000+	12000	330000
EATING DEER	0.0000	1000000+	190000	1000000+
EATING BIRD	0.0001	1000000+	73000	1000000+
EATING FISH	0.0002	1000000+	17000	450000
For Combined Routes of Exposure				
HIKER	0.0002	1000000+	23000	610000
BERRYPICKER	0.0006	1000000+	6200	170000
HUNTER	0.0002	1000000+	16000	430000
FISHERMAN	0.0004	1000000+	9600	260000
RESIDENT	0.0005	1000000+	7900	210000

[a] The plus sign (+) means "greater than."

Table C-44

Margins of Safety for Exposed Members of the Public
Aerial Routine-Worst Case Scenario
Atrazine Sprayed on 400 acres by Fixed Wing

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1869.0)	SYSTEMIC NOEL (3.70)	REPRODUCTIVE NOEL (100.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0170	110000	220	5900
VEGETATION CONTACT				
HIKER	0.0002	1000000+[a]	15000	410000
PICKER	0.0438	43000	85	2300
DRINKING WATER	0.0127	150000	290	7900
EATING BERRIES	0.0104	180000	350	9600
EATING VEGETS.	0.0208	90000	180	4800
EATING DEER	0.0016	1000000+	2300	61000
EATING BIRD	0.0071	260000	520	14000
EATING FISH	0.0254	74000	150	3900
For Combined Routes of Exposure				
HIKER	0.0299	62000	120	3300
BERRYPICKER	0.0839	22000	44	1200
HUNTER	0.0386	48000	96	2600
FISHERMAN	0.0553	34000	67	1800
RESIDENT	0.0508	37000	73	2000

[a] The plus sign (+) means "greater than."

Table C-45

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Atrazine Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1869.0)	SYSTEMIC NOEL (3.70)	REPRODUCTIVE NOEL (100.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0007	1000000+[a]	5400	150000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	380000	1000000+
PICKER	0.0018	1000000+	2100	57000
DRINKING WATER	0.0004	1000000+	9700	260000
EATING BERRIES	0.0007	1000000+	5000	140000
EATING VEGETS.	0.0015	1000000+	2500	68000
EATING DEER	0.0001	1000000+	38000	1000000
EATING BIRD	0.0003	1000000+	12000	330000
EATING FISH	0.0008	1000000+	4800	130000
For Combined Routes of Exposure				
HIKER	0.0011	1000000+	3400	93000
BERRYPICKER	0.0036	520000	1000	28000
HUNTER	0.0015	1000000+	2500	68000
FISHERMAN	0.0018	1000000	2000	54000
RESIDENT	0.0026	730000	1400	39000

[a] The plus sign (+) means "greater than."

Table C-46

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Atrazine Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1869.0)	SYSTEMIC NOEL (3.70)	REPRODUCTIVE NOEL (100.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0005	1000000+[a]	7300	200000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	510000	1000000+
PICKER	0.0013	1000000+	2800	76000
DRINKING WATER	0.0004	1000000+	8700	240000
EATING BERRIES	0.0007	1000000+	5600	150000
EATING VEGETS.	0.0013	1000000+	2800	76000
EATING DEER	0.0001	1000000+	44000	1000000+
EATING BIRD	0.0002	1000000+	16000	430000
EATING FISH	0.0008	1000000+	4400	120000
For Combined Routes of Exposure				
HIKER	0.0009	1000000+	3900	110000
BERRYPICKER	0.0029	640000	1300	34000
HUNTER	0.0013	1000000+	2900	80000
FISHERMAN	0.0018	1000000	2100	56000
RESIDENT	0.0023	830000	1600	44000

[a] The plus sign (+) means "greater than."

Table C-47

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Bromacil Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (3998.0)	SYSTEMIC NOEL (6.25)	REPRODUCTIVE NOEL (7.92)
For Single Route of Exposure				
DERMAL, SPRAY	0.0004	1000000+[a]	18000	22000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0014	1000000+	4400	5600
DRINKING WATER	0.0003	1000000+	19000	24000
EATING BERRIES	0.0006	1000000+	10000	13000
EATING VEGETS.	0.0012	1000000+	5100	6500
EATING DEER	0.0001	1000000+	78000	99000
EATING BIRD	0.0002	1000000+	26000	32000
EATING FISH	0.0001	1000000+	47000	60000
For Combined Routes of Exposure:				
HIKER	0.0007	1000000+	9000	11000
BERRYPICKER	0.0027	1000000+	2300	2900
HUNTER	0.0010	1000000+	6100	7800
FISHERMAN	0.0008	1000000+	7600	9600
RESIDENT	0.0019	1000000+	3300	4100

[a] The plus sign (+) means "greater than."

Table C-48

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
Bromacil Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (3998.0)	SYSTEMIC NOEL (6.25)	REPRODUCTIVE NOEL (7.92)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	91000	110000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0004	1000000+	17000	21000
DRINKING WATER	0.0001	1000000+	42000	53000
EATING BERRIES	0.0002	1000000+	31000	39000
EATING VEGETS.	0.0004	1000000+	15000	19000
EATING DEER	0.0000	1000000+	250000	310000
EATING BIRD	0.0001	1000000+	92000	120000
EATING FISH	0.0001	1000000+	100000	130000
For Combined Routes of Exposure				
HIKER	0.0002	1000000+	29000	36000
BERRYPICKER	0.0008	1000000+	7900	10000
HUNTER	0.0003	1000000+	20000	25000
FISHERMAN	0.0003	1000000+	22000	28000
RESIDENT	0.0006	1000000+	10000	13000

[a] The plus sign (+) means "greater than."

Table C-49

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Bromacil Sprayed on 60 acres

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (3998.0)	SYSTEMIC NOEL (6.25)	REPRODUCTIVE NOEL (7.92)
For Single Route of Exposure				
DERMAL, SPRAY	0.0017	1000000+[a]	3600	4600
VEGETATION CONTACT				
HIKER	0.0000	1000000+	250000	320000
PICKER	0.0044	910000	1400	1800
DRINKING WATER	0.0010	1000000+	6500	8300
EATING BERRIES	0.0018	1000000+	3400	4300
EATING VEGETS.	0.0037	1000000+	1700	2100
EATING DEER	0.0002	1000000+	26000	33000
EATING BIRD	0.0008	1000000+	8200	10000
EATING FISH	0.0004	1000000+	16000	21000
For Combined Routes of Exposure				
HIKER	0.0027	1000000+	2300	2900
BERRYPICKER	0.0089	450000	700	890
HUNTER	0.0037	1000000+	1700	2100
FISHERMAN	0.0031	1000000+	2000	2600
RESIDENT	0.0064	630000	980	1200

[a] The plus sign (+) means "greater than."

Table C-50

Margins of Safety for Exposed Members of the Public
Right of Way Routine–Worst Case Scenario
Bromacil Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (3998.0)	SYSTEMIC NOEL (6.25)	REPRODUCTIVE NOEL (7.92)
For Single Route of Exposure				
DERMAL, SPRAY	0.0006	1000000+[a]	10000	13000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	730000	920000
PICKER	0.0015	1000000+	4000	5100
DRINKING WATER	0.0005	1000000+	13000	16000
EATING BERRIES	0.0008	1000000+	8100	10000
EATING VEGETS.	0.0016	1000000+	4000	5100
EATING DEER	0.0001	1000000+	64000	81000
EATING BIRD	0.0003	1000000+	23000	29000
EATING FISH	0.0002	1000000+	31000	40000
For Combined Routes of Exposure				
HIKER	0.0011	1000000+	5700	7200
BERRY PICKER	0.0034	1000000+	1800	2300
HUNTER	0.0015	1000000+	4200	5400
FISHERMAN	0.0013	1000000+	4800	6100
RESIDENT	0.0027	1000000+	2400	3000

[a] The plus sign (+) means "greater than."

Table C-51

Margins of Safety for Exposed Members of the Public
Aerial Routine-Realistic Scenario
2,4-D Sprayed on 40 acres by Helicopter

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (375.0)	SYSTEMIC NOEL (1.00)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	83000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0024	150000	410	2000
DRINKING WATER	0.0024	160000	420	2200
EATING BERRIES	0.0013	280000	740	3800
EATING VEGETS.	0.0027	140000	370	1900
EATING DEER	0.0002	1000000+	5300	26000
EATING BIRD	0.0007	570000	1500	7600
EATING FISH	0.0009	400000	1100	5400
For Combined Routes of Exposure:				
HIKER	0.0024	160000	420	2200
BERRYPICKER	0.0061	61000	160	820
HUNTER	0.0032	120000	310	1600
FISHERMAN	0.0033	110000	300	1500
RESIDENT	0.0051	74000	200	980

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[a] The plus sign (+) means "greater than."

Table C-52

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
2,4-D Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (375.0)	SYSTEMIC NOEL (1.00)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	9400	4600
VEGETATION CONTACT				
HIKER	0.0000	1000000+	650000	1000000+
PICKER	0.0004	890000	2400	12000
DRINKING WATER	0.0002	1000000+	6000	30000
EATING BERRIES	0.0003	1000000+	3300	16000
EATING VEGETS.	0.0006	610000	1600	8200
EATING DEER	0.0000	1000000+	26000	130000
EATING BIRD	0.0001	1000000+	8500	42000
EATING FISH	0.0001	1000000+	15000	76000
For Combined Routes of Exposure:				
HIKER	0.0003	1000000+	3600	18000
BERRYPICKER	0.0010	370000	1000	5000
HUNTER	0.0004	870000	2300	12000
FISHERMAN	0.0003	1000000+	2900	15000
RESIDENT	0.0009	420000	1100	5600

[a] The plus sign (+) means "greater than."

Table C-53

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
2,4-D Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (375.0)	SYSTEMIC NOEL (1.00)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	39000	19000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0001	1000000+	7100	36000
DRINKING WATER	0.0001	1000000+	11000	54000
EATING BERRIES	0.0001	1000000+	7800	40000
EATING VEGETS.	0.0003	1000000+	3900	20000
EATING DEER	0.0000	1000000+	64000	1000000+
EATING BIRD	0.0000	1000000+	25000	120000
EATING FISH	0.0000	1000000+	27000	130000
For Combined Routes of Exposure:				
HIKER	0.0001	1000000+	8400	42000
BERRYPICKER	0.0004	970000	2600	13000
HUNTER	0.0002	1000000+	5700	28000
FISHERMAN	0.0002	1000000+	6400	32000
RESIDENT	0.0004	1000000	2700	13000

[a] The plus sign (+) means "greater than."

Table C-54

Margins of Safety for Exposed Members of the Public
Aerial Routine-Worst Case Scenario
2,4-D Sprayed on 400 acres by Fixed Wing

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (375.0)	SYSTEMIC NOEL (1.00)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0102	37000	98	500
VEGETATION CONTACT				
HIKER	0.0001	1000000+[a]	6800	34000
PICKER	0.0263	14000	38	190
DRINKING WATER	0.0127	30000	79	400
EATING BERRIES	0.0104	36000	96	480
EATING VEGETS.	0.0208	18000	48	240
EATING DEER	0.0016	240000	630	3200
EATING BIRD	0.0068	55000	150	740
EATING FISH	0.0051	74000	200	980
For Combined Routes of Exposure				
HIKER	0.0230	16000	43	220
BERRYPICKER	0.0596	6300	17	84
HUNTER	0.0314	12000	32	160
FISHERMAN	0.0281	13000	36	180
RESIDENT	0.0439	8500	23	110

[a] The plus sign (+) means "greater than."

Table C-55

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
2,4-D Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (375.0)	SYSTEMIC NOEL (1.00)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0004	910000	2400	12000
VEGETATION CONTACT				
HIKER	0.0000	1000000+[a]	170000	1000000+
PICKER	0.0011	350000	940	4800
DRINKING WATER	0.0004	980000	2600	13000
EATING BERRIES	0.0007	510000	1400	68000
EATING VEGETS.	0.0015	250000	680	34000
EATING DEER	0.0001	1000000+	11000	52000
EATING BIRD	0.0003	1000000+	3400	17000
EATING FISH	0.0002	1000000+	6500	32000
For Combined Routes of Exposure				
HIKER	0.0008	470000	1300	6200
BERRYPICKER	0.0026	140000	390	1900
HUNTER	0.0012	320000	840	4200
FISHERMAN	0.0010	390000	1100	5200
RESIDENT	0.0023	160000	440	2200

[a] The plus sign (+) means "greater than."

Table C-56

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
2,4-D Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (375.0)	SYSTEMIC NOEL (1.00)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	6800	34000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	470000	1000000+
PICKER	0.0004	990000	2600	13000
DRINKING WATER	0.0002	1000000+	4900	24000
EATING BERRIES	0.0003	1000000+	3100	16000
EATING VEGETS.	0.0006	590000	1600	7800
EATING DEER	0.0000	1000000+	25000	130000
EATING BIRD	0.0001	1000000+	9300	46000
EATING FISH	0.0001	1000000+	12000	62000
For Combined Routes of Exposure:				
HIKER	0.0004	1000000+	2800	14000
BERRYPICKER	0.0010	360000	950	4800
HUNTER	0.0005	750000	2000	10000
FISHERMAN	0.0004	860000	2300	11000
RESIDENT	0.0010	380000	1000	5000

[a] The plus sign (+) means "greater than."

Table C-57

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
2,4-DP Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (532.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (6.25)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	44000	55000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0005	1000000+	11000	14000
DRINKING WATER	0.0002	1000000+	30000	38000
EATING BERRIES	0.0003	1000000+	16000	20000
EATING VEGETS.	0.0006	870000	8200	10000
EATING DEER	0.0000	1000000+	130000	160000
EATING BIRD	0.0001	1000000+	43000	53000
EATING FISH	0.0001	1000000+	75000	94000
For Combined Routes of Exposure				
HIKER	0.0003	1000000+	18000	22000
BERRYPICKER	0.0010	510000	4800	6000
HUNTER	0.0004	1000000+	11000	14000
FISHERMAN	0.0003	1000000+	14000	18000
RESIDENT	0.0009	600000	5600	7000

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[a] The plus sign (+) means "greater than."

Table C-58

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
2,4-DP Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (532.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (6.25)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	180000	230000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0001	1000000+	33000	42000
DRINKING WATER	0.0001	1000000+	54000	67000
EATING BERRIES	0.0001	1000000+	39000	49000
EATING VEGETS.	0.0003	1000000+	20000	24000
EATING DEER	0.0000	1000000+	320000	400000
EATING BIRD	0.0000	1000000+	120000	150000
EATING FISH	0.0000	1000000+	130000	170000
For Combined Routes of Exposure				
HIKER	0.0001	1000000+	41000	52000
BERRYPICKER	0.0004	1000000+	13000	16000
HUNTER	0.0002	1000000+	28000	35000
FISHERMAN	0.0002	1000000+	32000	40000
RESIDENT	0.0004	1000000+	13000	17000

[a] The plus sign (+) means "greater than."

Table C-59

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
2,4-DP Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (532.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (6.25)
For Single Route of Exposure				
DERMAL, SPRAY	0.0005	1000000+[a]	11000	13000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	740000	920000
PICKER	0.0012	440000	4100	5100
DRINKING WATER	0.0004	1000000+	12000	15000
EATING BERRIES	0.0008	670000	6300	7900
EATING VEGETS.	0.0016	340000	3200	3900
EATING DEER	0.0001	1000000+	49000	61000
EATING BIRD	0.0003	1000000+	16000	20000
EATING FISH	0.0002	1000000+	30000	38000
For Combined Routes of Exposure				
HIKER	0.0009	600000	5600	7000
BERRYPICKER	0.0029	180000	1700	2200
HUNTER	0.0013	410000	3800	4800
FISHERMAN	0.0011	510000	4700	5900
RESIDENT	0.0025	220000	2000	2500

[a] The plus sign (+) means "greater than."

Table C-60

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
2,4-DP Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (532.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (6.25)
For Single Route of Exposure				
DERMAL, SPRAY	0.0002	1000000+[a]	26000	33000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0005	1000000+	10000	13000
DRINKING WATER	0.0002	1000000+	20000	25000
EATING BERRIES	0.0004	1000000+	13000	16000
EATING VEGETS.	0.0008	690000	6400	8100
EATING DEER	0.0000	1000000+	100000	130000
EATING BIRD	0.0001	1000000+	38000	47000
EATING FISH	0.0001	1000000+	50000	63000
For Combined Routes of Exposure:				
HIKER	0.0004	1000000+	11000	14000
BERRYPICKER	0.0013	400000	3800	4700
HUNTER	0.0006	850000	8000	10000
FISHERMAN	0.0005	980000	9200	12000
RESIDENT	0.0012	440000	4100	5100

[a] The plus sign (+) means "greater than."

Table C-61

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Dalapon Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (7577.0)	SYSTEMIC NOEL (15.00)	REPRODUCTIVE NOEL (300.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0004	1000000+[a]	42000	840000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0014	1000000+	11000	210000
DRINKING WATER	0.0003	1000000+	45000	900000
EATING BERRIES	0.0006	1000000+	25000	490000
EATING VEGETS.	0.0012	1000000+	12000	250000
EATING DEER	0.0001	1000000+	190000	1000000+
EATING BIRD	0.0002	1000000+	61000	1000000+
EATING FISH	0.0001	1000000+	110000	1000000+
For Combined Routes of Exposure				
HIKER	0.0007	1000000+	22000	430000
BERRYPICKER	0.0027	1000000+	5500	110000
HUNTER	0.0010	1000000+	15000	290000
FISHERMAN	0.0008	1000000+	18000	360000
RESIDENT	0.0019	1000000+	7800	160000

[a] The plus sign (+) means "greater than."

Table C-62

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
Dalapon Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (7577.0)	SYSTEMIC NOEL (15.00)	REPRODUCTIVE NOEL (300.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	220000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0004	1000000+	40000	800000
DRINKING WATER	0.0001	1000000+	100000	1000000+
EATING BERRIES	0.0002	1000000+	73000	1000000+
EATING VEGETS.	0.0004	1000000+	37000	730000
EATING DEER	0.0000	1000000+	590000	1000000+
EATING BIRD	0.0001	1000000+	220000	1000000+
EATING FISH	0.0001	1000000+	250000	1000000+
For Combined Routes of Exposure				
HIKER	0.0002	1000000+	69000	1000000+
BERRYPICKER	0.0008	1000000+	19000	380000
HUNTER	0.0003	1000000+	48000	960000
FISHERMAN	0.0003	1000000+	54000	1000000+
RESIDENT	0.0006	1000000+	24000	480000

[a] The plus sign (+) means "greater than."

Table C-63

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Dalapon Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (7577.0)	SYSTEMIC NOEL (15.00)	REPRODUCTIVE NOEL (300.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0021	1000000+[a]	7300	150000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	510000	1000000+
PICKER	0.0053	1000000+	2800	57000
DRINKING WATER	0.0011	1000000+	13000	260000
EATING BERRIES	0.0022	1000000+	6800	140000
EATING VEGETS.	0.0044	1000000+	3400	68000
EATING DEER	0.0003	1000000+	52000	1000000
EATING BIRD	0.0009	1000000+	16000	330000
EATING FISH	0.0005	1000000+	33000	650000
For Combined Routes of Exposure				
HIKER	0.0032	1000000+	4600	93000
BERRYPICKER	0.0107	710000	1400	28000
HUNTER	0.0044	1000000+	3400	68000
FISHERMAN	0.0037	1000000+	4100	81000
RESIDENT	0.0077	990000	2000	39000

[a] The plus sign (+) means "greater than."

Table C-64

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Dalapon Sprayed on 40 acres

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (7577.0)	SYSTEMIC NOEL (15.00)	REPRODUCTIVE NOEL (300.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0006	1000000+[a]	25000	500000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0015	1000000+	9700	190000
DRINKING WATER	0.0005	1000000+	30000	600000
EATING BERRIES	0.0008	1000000+	19000	390000
EATING VEGETS.	0.0016	1000000+	9700	190000
EATING DEER	0.0001	1000000+	150000	1000000+
EATING BIRD	0.0003	1000000+	54000	1000000+
EATING FISH	0.0002	1000000+	75000	1000000+
For Combined Routes of Exposure				
HIKER	0.0011	1000000+	14000	270000
BERRYPICKER	0.0034	1000000+	4400	88000
HUNTER	0.0015	1000000+	10000	200000
FISHERMAN	0.0013	1000000+	11000	230000
RESIDENT	0.0027	1000000+	5600	110000

[a] The plus sign (+) means "greater than."

Table C-65

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Dicamba Sprayed on 6 acres

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (757.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (2.50)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	1000000+	110000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0001	1000000+	280000	28000
DRINKING WATER	0.0000	1000000+	600000	60000
EATING BERRIES	0.0001	1000000+	330000	33000
EATING VEGETS.	0.0002	1000000+	160000	16000
EATING DEER	0.0000	1000000+	1000000+	260000
EATING BIRD	0.0000	1000000+	860000	86000
EATING FISH	0.0000	1000000+	1000000+	150000
For Combined Routes of Exposure				
HIKER	0.0001	1000000+	390000	39000
BERRYPICKER	0.0002	1000000+	110000	11000
HUNTER	0.0001	1000000+	240000	24000
FISHERMAN	0.0001	1000000+	310000	31000
RESIDENT	0.0002	1000000+	120000	12000

[a] The plus sign (+) means "greater than."

Table C-66

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
Dicamba Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (757.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (2.50)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	1000000+	290000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0000	1000000+	540000	54000
DRINKING WATER	0.0000	1000000+	670000	67000
EATING BERRIES	0.0001	1000000+	490000	49000
EATING VEGETS.	0.0001	1000000+	240000	24000
EATING DEER	0.0000	1000000+	1000000+	400000
EATING BIRD	0.0000	1000000+	1000000+	160000
EATING FISH	0.0000	1000000+	1000000+	170000
For Combined Routes of Exposure				
HIKER	0.0000	1000000+	540000	54000
BERRYPICKER	0.0001	1000000+	170000	17000
HUNTER	0.0001	1000000+	370000	37000
FISHERMAN	0.0001	1000000+	410000	41000
RESIDENT	0.0001	1000000+	170000	17000

[a] The plus sign (+) means "greater than."

Table C-67

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Dicamba Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD$_{50}$ (757.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (2.50)
For Single Route of Exposure				
DERMAL, SPRAY	0.0003	1000000+[a]	73000	7300
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	510000
PICKER	0.0009	860000	28000	2800
DRINKING WATER	0.0004	1000000+	65000	6500
EATING BERRIES	0.0007	1000000	34000	3400
EATING VEGETS.	0.0015	510000	17000	1700
EATING DEER	0.0001	1000000+	260000	26000
EATING BIRD	0.0003	1000000+	87000	8700
EATING FISH	0.0002	1000000+	160000	16000
For Combined Routes of Exposure				
HIKER	0.0007	1000000	34000	3400
BERRYPICKER	0.0023	320000	11000	1100
HUNTER	0.0011	680000	22000	2200
FISHERMAN	0.0009	860000	28000	2800
RESIDENT	0.0022	340000	11000	1100

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[a] The plus sign (+) means "greater than."

Table C-68

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Dicamba Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (757.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (2.50)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	230000	23000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0003	1000000+	90000	9000
DRINKING WATER	0.0002	1000000+	140000	14000
EATING BERRIES	0.0003	1000000+	90000	9000
EATING VEGETS.	0.0006	1000000+	45000	4500
EATING DEER	0.0000	1000000+	720000	72000
EATING BIRD	0.0001	1000000+	270000	27000
EATING FISH	0.0001	1000000+	350000	35000
For Combined Routes of Exposure				
HIKER	0.0003	1000000+	87000	8700
BERRYPICKER	0.0008	900000	30000	3000
HUNTER	0.0004	1000000+	60000	6000
FISHERMAN	0.0004	1000000+	69000	6900
RESIDENT	0.0008	890000	30000	3000

[a] The plus sign (+) means "greater than."

Table C-69

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Diuron Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (3750.0)	SYSTEMIC NOEL (0.63)	REPRODUCTIVE NOEL (6.25)
For Single Route of Exposure				
DERMAL, SPRAY	0.0004	1000000+[a]	1800	18000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	120000	1000000+
PICKER	0.0014	1000000+	440	4400
DRINKING WATER	0.0003	1000000+	1900	19000
EATING BERRIES	0.0006	1000000+	1000	10000
EATING VEGETS.	0.0012	1000000+	510	5100
EATING DEER	0.0001	1000000+	7800	78000
EATING BIRD	0.0002	1000000+	2600	26000
EATING FISH	0.0027	1000000+	240	2400
For Combined Routes of Exposure				
HIKER	0.0007	1000000+	900	9000
BERRYPICKER	0.0027	1000000+	230	2300
HUNTER	0.0010	1000000+	610	6100
FISHERMAN	0.0033	1000000+	190	1900
RESIDENT	0.0019	1000000+	330	3300

[a] The plus sign (+) means "greater than."

Table C-70

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
Diuron Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (3750.0)	SYSTEMIC NOEL (0.63)	REPRODUCTIVE NOEL (6.25)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	9100	91000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	630000	1000000+
PICKER	0.0004	1000000+	1700	17000
DRINKING WATER	0.0001	1000000+	4200	42000
EATING BERRIES	0.0002	1000000+	3100	31000
EATING VEGETS.	0.0004	1000000+	1500	15000
EATING DEER	0.0000	1000000+	25000	250000
EATING BIRD	0.0001	1000000+	9200	92000
EATING FISH	0.0012	1000000+	520	5200
For Combined Routes of Exposure				
HIKER	0.0002	1000000+	2900	29000
BERRYPICKER	0.0008	1000000+	790	7900
HUNTER	0.0003	1000000+	2000	20000
FISHERMAN	0.0014	1000000+	440	4400
RESIDENT	0.0006	1000000+	1000	10000

[a] The plus sign (+) means "greater than."

Table C-71

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Diuron Sprayed on 60 acres

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (3750.0)	 SYSTEMIC NOEL (0.63)	 REPRODUCTIVE NOEL (6.25)
For Single Route of Exposure				
DERMAL, SPRAY	0.0010	1000000+[a]	610	6100
VEGETATION CONTACT				
HIKER	0.0000	1000000+	42000	420000
PICKER	0.0026	1000000+	240	2400
DRINKING WATER	0.0006	1000000+	1100	11000
EATING BERRIES	0.0011	1000000+	570	5700
EATING VEGETS.	0.0022	1000000+	280	2800
EATING DEER	0.0001	1000000+	4300	43000
EATING BIRD	0.0005	1000000+	1400	14000
EATING FISH	0.0046	820000	140	1400
For Combined Routes of Exposure				
HIKER	0.0016	1000000+	390	3900
BERRYPICKER	0.0054	700000	120	1200
HUNTER	0.0022	1000000+	280	2800
FISHERMAN	0.0062	600000	100	1000
RESIDENT	0.0038	980000	160	1600

[a] The plus sign (+) means "greater than."

Table C-72

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Diuron Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (3750.0)	SYSTEMIC NOEL (0.63)	REPRODUCTIVE NOEL (6.25)
For Single Route of Exposure				
DERMAL, SPRAY	0.0010	1000000+[a]	650	6500
VEGETATION CONTACT				
HIKER	0.0000	1000000+	45000	450000
PICKER	0.0025	1000000+	250	2500
DRINKING WATER	0.0008	1000000+	780	7800
EATING BERRIES	0.0012	1000000+	500	5000
EATING VEGETS.	0.0025	1000000+	250	2500
EATING DEER	0.0002	1000000+	4000	40000
EATING BIRD	0.0004	1000000+	1400	14000
EATING FISH	0.0064	590000	98	980
For Combined Routes of Exposure				
HIKER	0.0018	1000000+	350	3500
BERRYPICKER	0.0055	690000	110	1100
HUNTER	0.0024	1000000+	260	2600
FISHERMAN	0.0081	460000	77	770
RESIDENT	0.0043	880000	150	1500

[a] The plus sign (+) means "greater than."

Table C-73

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Fosamine Sprayed on 6 acres

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD$_{50}$ (24400.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (500.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0003	1000000+[a]	94000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0011	1000000+	24000	740000
DRINKING WATER	0.0002	1000000+	100000	1000000+
EATING BERRIES	0.0005	1000000+	54000	1000000
EATING VEGETS.	0.0009	1000000+	27000	850000
EATING DEER	0.0001	1000000+	420000	1000000+
EATING BIRD	0.0002	1000000+	140000	1000000+
EATING FISH	0.0001	1000000+	250000	1000000+
For Combined Routes of Exposure				
HIKER	0.0005	1000000+	48000	1000000
BERRYPICKER	0.0020	1000000+	12000	380000
HUNTER	0.0008	1000000+	33000	1000000+
FISHERMAN	0.0006	1000000+	40000	830000
RESIDENT	0.0014	1000000+	17000	540000

[a] The plus sign (+) means "greater than."

Table C-74

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
Fosamine Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (24400.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (500.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	360000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0004	1000000+	67000	1000000+
DRINKING WATER	0.0001	1000000+	170000	1000000+
EATING BERRIES	0.0002	1000000+	120000	1000000+
EATING VEGETS.	0.0004	1000000+	61000	1000000+
EATING DEER	0.0000	1000000+	980000	1000000+
EATING BIRD	0.0001	1000000+	370000	1000000+
EATING FISH	0.0001	1000000+	420000	1000000+
For Combined Routes of Exposure				
HIKER	0.0002	1000000+	110000	1000000+
BERRYPICKER	0.0008	1000000+	31000	630000
HUNTER	0.0003	1000000+	80000	1000000+
FISHERMAN	0.0003	1000000+	90000	1000000+
RESIDENT	0.0006	1000000+	40000	83000

[a] The plus sign (+) means "greater than."

Table C-75

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Fosamine Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (24400.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (500.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0020	1000000+[a]	13000	250000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	880000	1000000+
PICKER	0.0051	1000000+	4900	100000
DRINKING WATER	0.0011	1000000+	23000	450000
EATING BERRIES	0.0021	1000000+	12000	230000
EATING VEGETS.	0.0042	1000000+	5900	120000
EATING DEER	0.0003	1000000+	90000	1000000+
EATING BIRD	0.0009	1000000+	29000	570000
EATING FISH	0.0004	1000000+	57000	1000000+
For Combined Routes of Exposure				
HIKER	0.0031	1000000+	8100	160000
BERRYPICKER	0.0103	1000000+	2400	490000
HUNTER	0.0043	1000000+	5900	120000
FISHERMAN	0.0035	1000000+	7100	140000
RESIDENT	0.0073	1000000+	3400	67000

[a] The plus sign (+) means "greater than."

Table C-76

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Fosamine Sprayed on 40 acres

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (24400.0)	 SYSTEMIC NOEL (25.00)	 REPRODUCTIVE NOEL (500.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0006	1000000+[a]	39000	830000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0017	1000000+	15000	300000
DRINKING WATER	0.0005	1000000+	47000	1000000+
EATING BERRIES	0.0008	1000000+	30000	600000
EATING VEGETS.	0.0017	1000000+	15000	300000
EATING DEER	0.0001	1000000+	240000	1000000+
EATING BIRD	0.0003	1000000+	85000	1000000+
EATING FISH	0.0002	1000000+	120000	1000000+
For Combined Routes of Exposure				
HIKER	0.0012	1000000+	21000	420000
BERRYPICKER	0.0037	1000000+	6800	140000
HUNTER	0.0016	1000000+	16000	310000
FISHERMAN	0.0014	1000000+	18000	360000
RESIDENT	0.0028	1000000+	8800	170000

[a] The plus sign (+) means "greater than."

Table C-77

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Glyphosate Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4320.0)	SYSTEMIC NOEL (31.00)	REPRODUCTIVE NOEL (10.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	230000	75000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0005	1000000+	59000	19000
DRINKING WATER	0.0001	1000000+	250000	80000
EATING BERRIES	0.0002	1000000+	140000	44000
EATING VEGETS.	0.0005	1000000+	68000	22000
EATING DEER	0.0000	1000000+	1000000+	330000
EATING BIRD	0.0001	1000000+	340000	110000
EATING FISH	0.0000	1000000+	620000	200000
For Combined Routes of Exposure				
HIKER	0.0003	1000000+	110000	38000
BERRYPICKER	0.0010	1000000+	31000	9800
HUNTER	0.0004	1000000+	82000	26000
FISHERMAN	0.0003	1000000+	100000	32000
RESIDENT	0.0007	1000000+	44000	14000

[a] The plus sign (+) means "greater than."

Table C-78

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
Glyphosate Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4320.0)	SYSTEMIC NOEL (31.00)	REPRODUCTIVE NOEL (10.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	900000	290000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0002	1000000+	170000	54000
DRINKING WATER	0.0001	1000000+	420000	130000
EATING BERRIES	0.0001	1000000+	300000	98000
EATING VEGETS.	0.0002	1000000+	160000	49000
EATING DEER	0.0000	1000000+	1000000+	780000
EATING BIRD	0.0000	1000000+	930000	300000
EATING FISH	0.0000	1000000+	1000000+	340000
For Combined Routes of Exposure				
HIKER	0.0001	1000000+	280000	91000
BERRYPICKER	0.0004	1000000+	78000	25000
HUNTER	0.0002	1000000+	200000	64000
FISHERMAN	0.0001	1000000+	230000	72000
RESIDENT	0.0003	1000000+	99000	32000

[a] The plus sign (+) means "greater than."

Table C-79

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Glyphosate Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4320.0)	SYSTEMIC NOEL (31.00)	REPRODUCTIVE NOEL (10.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0009	1000000+[a]	36000	12000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	810000
PICKER	0.0022	1000000+	15000	4500
DRINKING WATER	0.0005	1000000+	66000	21000
EATING BERRIES	0.0009	1000000+	34000	11000
EATING VEGETS.	0.0018	1000000+	17000	5400
EATING DEER	0.0001	1000000+	260000	83000
EATING BIRD	0.0004	1000000+	82000	26000
EATING FISH	0.0002	1000000+	170000	52000
For Combined Routes of Exposure				
HIKER	0.0013	1000000+	23000	7400
BERRYPICKER	0.0045	970000	7000	2200
HUNTER	0.0018	1000000+	17000	5400
FISHERMAN	0.0015	1000000+	21000	6500
RESIDENT	0.0032	1000000+	9800	3100

[a] The plus sign (+) means "greater than."

Table C-80

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Glyphosate Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4320.0)	SYSTEMIC NOEL (31.00)	REPRODUCTIVE NOEL (10.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0003	1000000+[a]	110000	33000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0008	1000000+	41000	13000
DRINKING WATER	0.0002	1000000+	130000	40000
EATING BERRIES	0.0004	1000000+	80000	26000
EATING VEGETS.	0.0008	1000000+	41000	13000
EATING DEER	0.0000	1000000+	630000	200000
EATING BIRD	0.0001	1000000+	230000	73000
EATING FISH	0.0001	1000000+	310000	100000
For Combined Routes of Exposure				
HIKER	0.0006	1000000+	56000	18000
BERRYPICKER	0.0017	1000000+	19000	5900
HUNTER	0.0007	1000000+	43000	14000
FISHERMAN	0.0007	1000000+	48000	15000
RESIDENT	0.0013	1000000+	24000	7500

[a] The plus sign (+) means "greater than."

Table C-81

Margins of Safety for Exposed Members of the Public
Aerial Routine-Realistic Scenario
Hexazinone Sprayed on 40 acres by Helicopter

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1690.0)	SYSTEMIC NOEL (10.00)	REPRODUCTIVE NOEL (125.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	500000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0041	420000	2500	31000
DRINKING WATER	0.0024	720000	4200	53000
EATING BERRIES	0.0013	1000000+	7400	93000
EATING VEGETS.	0.0027	630000	3700	46000
EATING DEER	0.0002	1000000+	52000	650000
EATING BIRD	0.0007	1000000+	15000	180000
EATING FISH	0.0009	1000000+	11000	130000
For Combined Routes of Exposure				
HIKER	0.0024	710000	4200	53000
BERRYPICKER	0.0078	220000	1300	16000
HUNTER	0.0033	520000	3100	38000
FISHERMAN	0.0033	510000	3000	38000
RESIDENT	0.0051	330000	2000	25000

[a] The plus sign (+) means "greater than."

Table C-82

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Hexazinone Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1690.0)	SYSTEMIC NOEL (10.00)	REPRODUCTIVE NOEL (125.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	100000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0004	1000000+	25000	320000
DRINKING WATER	0.0001	1000000+	110000	1000000+
EATING BERRIES	0.0002	1000000+	58000	730000
EATING VEGETS.	0.0003	1000000+	29000	360000
EATING DEER	0.0000	1000000+	450000	1000000+
EATING BIRD	0.0001	1000000+	150000	1000000+
EATING FISH	0.0000	1000000+	270000	1000000+
For Combined Routes of Exposure				
HIKER	0.0002	1000000+	52000	640000
BERRYPICKER	0.0008	1000000+	13000	160000
HUNTER	0.0003	1000000+	35000	440000
FISHERMAN	0.0002	1000000+	43000	540000
RESIDENT	0.0005	1000000+	19000	230000

[a] The plus sign (+) means "greater than."

Table C-83

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
Hexazinone Sprayed on 12 acres

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO		
		LD_{50} (1690.0)	SYSTEMIC NOEL (10.00)	REPRODUCTIVE NOEL (125.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	230000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0002	1000000+	43000	540000
DRINKING WATER	0.0001	1000000+	110000	1000000+
EATING BERRIES	0.0001	1000000+	78000	980000
EATING VEGETS.	0.0003	1000000+	39000	490000
EATING DEER	0.0000	1000000+	630000	1000000+
EATING BIRD	0.0000	1000000+	240000	1000000+
EATING FISH	0.0000	1000000+	270000	1000000+
For Combined Routes of Exposure				
HIKER	0.0001	1000000+	73000	910000
BERRYPICKER	0.0005	1000000+	20000	250000
HUNTER	0.0002	1000000+	51000	640000
FISHERMAN	0.0002	1000000+	57000	720000
RESIDENT	0.0004	1000000+	25000	320000

[a] The plus sign (+) means "greater than."

Table C-84

Margins of Safety for Exposed Members of the Public Aerial Routine-Worst Case Scenario Hexazinone Sprayed on 400 acres by Fixed Wing

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1690.0)	SYSTEMIC NOEL (10.00)	REPRODUCTIVE NOEL (125.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0127	130000	790	9800
VEGETATION CONTACT				
HIKER	0.0002	1000000+[a]	55000	680000
PICKER	0.0328	51000	300	3800
DRINKING WATER	0.0095	180000	1100	13000
EATING BERRIES	0.0078	220000	1300	16000
EATING VEGETS.	0.0156	110000	640	8000
EATING DEER	0.0012	1000000+	8200	100000
EATING BIRD	0.0053	320000	1900	23000
EATING FISH	0.0038	440000	2600	33000
For Combined Routes of Exposure				
HIKER	0.0224	75000	450	5600
BERRYPICKER	0.0629	27000	160	2000
HUNTER	0.0290	58000	350	4300
FISHERMAN	0.0262	64000	380	4800
RESIDENT	0.0381	44000	260	3300

[a] The plus sign (+) means "greater than."

Table C-85

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Hexazinone Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1690.0)	SYSTEMIC NOEL (10.00)	REPRODUCTIVE NOEL (125.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0005	1000000+[a]	19000	240000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0013	1000000+	7500	94000
DRINKING WATER	0.0003	1000000+	35000	440000
EATING BERRIES	0.0006	1000000+	18000	230000
EATING VEGETS.	0.0011	1000000+	9000	110000
EATING DEER	0.0001	1000000+	140000	1000000+
EATING BIRD	0.0002	1000000+	44000	550000
EATING FISH	0.0001	1000000+	87000	1000000+
For Combined Routes of Exposure				
HIKER	0.0008	1000000+	12000	150000
BERRYPICKER	0.0027	630000	3700	47000
HUNTER	0.0011	1000000+	9000	110000
FISHERMAN	0.0009	1000000+	11000	140000
RESIDENT	0.0019	880000	5200	65000

[a] The plus sign (+) means "greater than."

Table C-86

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Hexazinone Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1690.0)	SYSTEMIC NOEL (10.00)	REPRODUCTIVE NOEL (125.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0004	1000000+[a]	28000	350000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0009	1000000+	11000	130000
DRINKING WATER	0.0003	1000000+	33000	420000
EATING BERRIES	0.0005	1000000+	21000	270000
EATING VEGETS.	0.0009	1000000+	11000	130000
EATING DEER	0.0001	1000000+	170000	1000000+
EATING BIRD	0.0002	1000000+	61000	760000
EATING FISH	0.0001	1000000+	84000	1000000
For Combined Routes of Exposure				
HIKER	0.0007	1000000+	15000	190000
BERRYPICKER	0.0021	820000	4900	61000
HUNTER	0.0009	1000000+	11000	140000
FISHERMAN	0.0008	1000000+	13000	160000
RESIDENT	0.0016	1000000+	6300	78000

[a] The plus sign (+) means "greater than."

Table C-87

Margins of Safety for Exposed Members of the Public
Aerial Routine-Realistic Scenario
Picloram Sprayed on 40 acres by Helicopter

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (8200.0)	SYSTEMIC NOEL (7.00)	REPRODUCTIVE NOEL (50.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	1000000+	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0001	1000000+	90000	640000
DRINKING WATER	0.0009	1000000+	7400	53000
EATING BERRIES	0.0005	1000000+	13000	93000
EATING VEGETS.	0.0011	1000000+	6500	46000
EATING DEER	0.0001	1000000+	96000	680000
EATING BIRD	0.0002	1000000+	29000	200000
EATING FISH	0.0004	1000000+	19000	130000
For Combined Routes of Exposure				
HIKER	0.0009	1000000+	7400	53000
BERRYPICKER	0.0016	1000000+	4500	32000
HUNTER	0.0013	1000000+	5600	40000
FISHERMAN	0.0013	1000000+	5300	38000
RESIDENT	0.0020	1000000+	3500	25000

[a] The plus sign (+) means "greater than."

Table C-88

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Picloram Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (8200.0)	SYSTEMIC NOEL (7.00)	REPRODUCTIVE NOEL (50.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	1000000+	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0000	1000000+	410000	1000000+
DRINKING WATER	0.0001	1000000+	84000	600000
EATING BERRIES	0.0002	1000000+	46000	330000
EATING VEGETS.	0.0003	1000000+	23000	160000
EATING DEER	0.0000	1000000+	370000	1000000+
EATING BIRD	0.0001	1000000+	130000	910000
EATING FISH	0.0000	1000000+	210000	1000000+
For Combined Routes of Exposure				
HIKER	0.0001	1000000+	80000	570000
BERRYPICKER	0.0003	1000000+	27000	190000
HUNTER	0.0002	1000000+	43000	310000
FISHERMAN	0.0001	1000000+	58000	420000
RESIDENT	0.0004	1000000+	18000	130000

[a] The plus sign (+) means "greater than."

Table C-89

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
Picloram Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (8200.0)	SYSTEMIC NOEL (7.00)	REPRODUCTIVE NOEL (50.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	1000000+	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0000	1000000+	1000000+	1000000+
DRINKING WATER	0.0000	1000000+	190000	1000000+
EATING BERRIES	0.0001	1000000+	140000	980000
EATING VEGETS.	0.0001	1000000+	68000	490000
EATING DEER	0.0000	1000000+	1000000+	1000000+
EATING BIRD	0.0000	1000000+	460000	1000000+
EATING FISH	0.0000	1000000+	470000	1000000+
For Combined Routes of Exposure				
HIKER	0.0000	1000000+	180000	1000000+
BERRYPICKER	0.0001	1000000+	75000	530000
HUNTER	0.0001	1000000+	120000	840000
FISHERMAN	0.0001	1000000+	130000	940000
RESIDENT	0.0001	1000000+	50000	360000

[a] The plus sign (+) means "greater than."

Table C-90

Margins of Safety for Exposed Members of the Public
Aerial Routine-Worst Case Scenario
Picloram Sprayed on 400 acres by Fixed Wing

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (8200.0)	SYSTEMIC NOEL (7.00)	REPRODUCTIVE NOEL (50.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0010	1000000+[a]	6900	49000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	480000	1000000+
PICKER	0.0026	1000000+	2700	19000
DRINKING WATER	0.0159	520000	440	3200
EATING BERRIES	0.0130	630000	540	3800
EATING VEGETS.	0.0261	310000	270	1900
EATING DEER	0.0019	1000000+	3700	26000
EATING BIRD	0.0079	1000000	890	6300
EATING FISH	0.0063	1000000+	1100	7900
For Combined Routes of Exposure				
HIKER	0.0169	490000	410	3000
BERRYPICKER	0.0325	250000	220	1500
HUNTER	0.0267	310000	260	1900
FISHERMAN	0.0232	350000	300	2200
RESIDENT	0.0429	190000	160	1200

[a] The plus sign (+) means "greater than."

Table C-91

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Picloram Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (8200.0)	SYSTEMIC NOEL (7.00)	REPRODUCTIVE NOEL (50.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	210000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0001	1000000+	83000	590000
DRINKING WATER	0.0004	1000000+	18000	130000
EATING BERRIES	0.0007	1000000+	9500	68000
EATING VEGETS.	0.0015	1000000+	4700	34000
EATING DEER	0.0001	1000000+	76000	540000
EATING BIRD	0.0003	1000000+	26000	180000
EATING FISH	0.0002	1000000+	46000	330000
For Combined Routes of Exposure				
HIKER	0.0004	1000000+	17000	120000
BERRYPICKER	0.0012	1000000+	5700	40000
HUNTER	0.0008	1000000+	9000	64000
FISHERMAN	0.0006	1000000+	12000	88000
RESIDENT	0.0019	1000000+	3700	26000

[a] The plus sign (+) means "greater than."

Table C-92

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Picloram Sprayed on 40 acres

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO		
		LD_{50} (8200.0)	SYSTEMIC NOEL (7.00)	REPRODUCTIVE NOEL (50.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	1000000+	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0000	1000000+	470000	1000000+
DRINKING WATER	0.0001	1000000+	70000	500000
EATING BERRIES	0.0002	1000000+	45000	320000
EATING VEGETS.	0.0003	1000000+	23000	160000
EATING DEER	0.0000	1000000+	370000	1000000+
EATING BIRD	0.0000	1000000+	140000	1000000
EATING FISH	0.0000	1000000+	180000	1000000+
For Combined Routes of Exposure:				
HIKER	0.0001	1000000+	66000	470000
BERRYPICKER	0.0003	1000000+	25000	180000
HUNTER	0.0002	1000000+	40000	290000
FISHERMAN	0.0001	1000000+	48000	340000
RESIDENT	0.0004	1000000+	17000	120000

[a] The plus sign (+) means "greater than."

Table C-93

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Simazine Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (5000.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0002	1000000+[a]	28000	28000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0007	1000000+	7100	7100
DRINKING WATER	0.0002	1000000+	30000	30000
EATING BERRIES	0.0003	1000000+	16000	16000
EATING VEGETS.	0.0006	1000000+	8200	8200
EATING DEER	0.0000	1000000+	130000	130000
EATING BIRD	0.0001	1000000+	41000	41000
EATING FISH	0.0001	1000000+	75000	75000
For Combined Routes of Exposure				
HIKER	0.0003	1000000+	14000	14000
BERRYPICKER	0.0014	1000000+	3700	3700
HUNTER	0.0005	1000000+	9800	9800
FISHERMAN	0.0004	1000000+	12000	12000
RESIDENT	0.0010	1000000+	5200	5200

[a] The plus sign (+) means "greater than."

Table C-94

Margins of Safety for Exposed Members of the Public Right-of-Way Routine-Realistic Scenario Simazine Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (5000.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	140000	140000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0002	1000000+	27000	27000
DRINKING WATER	0.0001	1000000+	67000	67000
EATING BERRIES	0.0001	1000000+	49000	49000
EATING VEGETS.	0.0002	1000000+	24000	24000
EATING DEER	0.0000	1000000+	390000	390000
EATING BIRD	0.0000	1000000+	150000	150000
EATING FISH	0.0000	1000000+	170000	170000
For Combined Routes of Exposure				
HIKER	0.0001	1000000+	46000	46000
BERRYPICKER	0.0004	1000000+	13000	13000
HUNTER	0.0002	1000000+	32000	32000
FISHERMAN	0.0001	1000000+	36000	36000
RESIDENT	0.0003	1000000+	16000	16000

[a] The plus sign (+) means "greater than."

Table C-95

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Simazine Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (5000.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0008	1000000+[a]	6300	6300
VEGETATION CONTACT				
HIKER	0.0000	1000000+	440000	440000
PICKER	0.0020	1000000+	2500	2500
DRINKING WATER	0.0004	1000000+	11000	11000
EATING BERRIES	0.0008	1000000+	5900	5900
EATING VEGETS.	0.0017	1000000+	2900	2900
EATING DEER	0.0001	1000000+	45000	45000
EATING BIRD	0.0004	1000000+	14000	14000
EATING FISH	0.0002	1000000+	28000	28000
For Combined Routes of Exposure				
HIKER	0.0012	1000000+	4000	4000
BERRYPICKER	0.0041	1000000+	1200	1200
HUNTER	0.0017	1000000+	2900	2900
FISHERMAN	0.0014	1000000+	3500	3500
RESIDENT	0.0029	1000000+	1700	1700

[a] The plus sign (+) means "greater than."

Table C-96

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Simazine Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (5000.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0003	1000000+[a]	18000	18000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0007	1000000+	7000	7000
DRINKING WATER	0.0002	1000000+	22000	22000
EATING BERRIES	0.0004	1000000+	14000	14000
EATING VEGETS.	0.0007	1000000+	7000	7000
EATING DEER	0.0000	1000000+	110000	110000
EATING BIRD	0.0001	1000000+	39000	39000
EATING FISH	0.0001	1000000+	55000	55000
For Combined Routes of Exposure				
HIKER	0.0005	1000000+	9800	9800
BERRYPICKER	0.0016	1000000+	3200	3200
HUNTER	0.0007	1000000+	7300	7300
FISHERMAN	0.0006	1000000+	8300	8300
RESIDENT	0.0012	1000000+	4100	4100

[a] The plus sign (+) means "greater than."

Table C-97

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Tebuthiuron Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (644.0)	SYSTEMIC NOEL (12.50)	REPRODUCTIVE NOEL (90.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0001	1000000+[a]	94000	670000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0005	1000000+	24000	170000
DRINKING WATER	0.0001	1000000+	100000	720000
EATING BERRIES	0.0002	1000000+	54000	390000
EATING VEGETS.	0.0005	1000000+	27000	200000
EATING DEER	0.0000	1000000+	420000	1000000+
EATING BIRD	0.0001	1000000+	140000	980000
EATING FISH	0.0005	1000000+	25000	180000
For Combined Routes of Exposure				
HIKER	0.0003	1000000+	48000	350000
BERRYPICKER	0.0010	630000	12000	89000
HUNTER	0.0004	1000000+	33000	240000
FISHERMAN	0.0008	850000	17000	120000
RESIDENT	0.0007	900000	17000	130000

[a] The plus sign (+) means "greater than."

Table C-98

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
Tebuthiuron Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (644.0)	SYSTEMIC NOEL (12.50)	REPRODUCTIVE NOEL (90.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	330000	1000000+
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0002	1000000+	61000	440000
DRINKING WATER	0.0001	1000000+	150000	1000000+
EATING BERRIES	0.0001	1000000+	110000	800000
EATING VEGETS.	0.0002	1000000+	56000	400000
EATING DEER	0.0000	1000000+	890000	1000000+
EATING BIRD	0.0000	1000000+	340000	1000000+
EATING FISH	0.0003	1000000+	38000	270000
For Combined Routes of Exposure				
HIKER	0.0001	1000000+	100000	750000
BERRYPICKER	0.0004	1000000+	29000	210000
HUNTER	0.0002	1000000+	73000	520000
FISHERMAN	0.0004	1000000+	28000	200000
RESIDENT	0.0003	1000000+	36000	260000

[a] The plus sign (+) means "greater than."

Table C-99

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Tebuthiuron Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (644.0)	SYSTEMIC NOEL (12.50)	REPRODUCTIVE NOEL (90.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0010	630000	12000	88000
VEGETATION CONTACT				
HIKER	0.0000	1000000+[a]	850000	1000000+
PICKER	0.0026	240000	4700	34000
DRINKING WATER	0.0006	1000000+	22000	160000
EATING BERRIES	0.0011	580000	11000	81000
EATING VEGETS.	0.0022	290000	5700	41000
EATING DEER	0.0001	1000000+	86000	620000
EATING BIRD	0.0005	1000000+	27000	200000
EATING FISH	0.0023	280000	5500	39000
For Combined Routes of Exposure				
HIKER	0.0016	400000	7700	56000
BERRYPICKER	0.0054	120000	2300	17000
HUNTER	0.0022	290000	5600	41000
FISHERMAN	0.0039	160000	3200	23000
RESIDENT	0.0038	170000	3300	24000

[a] The plus sign (+) means "greater than."

Table C-100

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Tebuthiuron Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (644.0)	SYSTEMIC NOEL (12.50)	REPRODUCTIVE NOEL (90.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0003	1000000+[a]	45000	330000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0007	910000	18000	130000
DRINKING WATER	0.0002	1000000+	55000	390000
EATING BERRIES	0.0004	1000000+	35000	250000
EATING VEGETS.	0.0007	900000	18000	130000
EATING DEER	0.0000	1000000+	280000	1000000+
EATING BIRD	0.0001	1000000+	99000	710000
EATING FISH	0.0009	700000	14000	98000
For Combined Routes of Exposure				
HIKER	0.0005	1000000+	25000	180000
BERRYPICKER	0.0016	410000	7900	57000
HUNTER	0.0007	950000	18000	130000
FISHERMAN	0.0014	450000	8800	63000
RESIDENT	0.0012	530000	10000	74000

[a] The plus sign (+) means "greater than."

Table C-101

Margins of Safety for Exposed Members of the Public
Aerial Routine-Realistic Scenario
Triclopyr Sprayed on 40 acres by Helicopter

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO		
		LD_{50} (630.0)	SYSTEMIC NOEL (2.50)	REPRODUCTIVE NOEL (10.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	160000	620000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0032	190000	770	3100
DRINKING WATER	0.0019	330000	1300	5300
EATING BERRIES	0.0011	580000	2300	9300
EATING VEGETS.	0.0022	290000	1200	4600
EATING DEER	0.0002	1000000+	16000	65000
EATING BIRD	0.0005	1000000+	4500	18000
EATING FISH	0.0008	840000	3300	13000
For Combined Routes of Exposure				
HIKER	0.0019	330000	1300	5300
BERRYPICKER	0.0062	100000	400	1600
HUNTER	0.0026	240000	960	3800
FISHERMAN	0.0027	240000	940	3800
RESIDENT	0.0041	160000	620	2500

[a] The plus sign (+) means "greater than."

Table C-102

Margins of Safety for Exposed Members of the Public
Backpack Routine-Realistic Scenario
Triclopyr Sprayed on 6 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (630.0)	SYSTEMIC NOEL (2.50)	REPRODUCTIVE NOEL (10.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0002	1000000+[a]	14000	56000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	980000	1000000+
PICKER	0.0007	890000	3500	14000
DRINKING WATER	0.0002	1000000+	15000	60000
EATING BERRIES	0.0003	1000000+	8200	33000
EATING VEGETS.	0.0006	1000000	4100	16000
EATING DEER	0.0000	1000000+	63000	250000
EATING BIRD	0.0001	1000000+	20000	82000
EATING FISH	0.0001	1000000+	38000	150000
For Combined Routes of Exposure				
HIKER	0.0003	1000000+	7200	29000
BERRYPICKER	0.0014	470000	1800	7400
HUNTER	0.0005	1000000+	4900	20000
FISHERMAN	0.0004	1000000+	6100	24000
RESIDENT	0.0010	660000	2600	10000

[a] The plus sign (+) means "greater than."

Table C-103

Margins of Safety for Exposed Members of the Public
Right-of-Way Routine-Realistic Scenario
Triclopyr Sprayed on 12 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (630.0)	SYSTEMIC NOEL (2.50)	REPRODUCTIVE NOEL (10.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0000	1000000+[a]	72000	290000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	1000000+	1000000+
PICKER	0.0002	1000000+	13000	54000
DRINKING WATER	0.0001	1000000+	34000	130000
EATING BERRIES	0.0001	1000000+	24000	98000
EATING VEGETS.	0.0002	1000000+	12000	49000
EATING DEER	0.0000	1000000+	200000	780000
EATING BIRD	0.0000	1000000+	74000	300000
EATING FISH	0.0000	1000000+	84000	340000
For Combined Routes of Exposure				
HIKER	0.0001	1000000+	23000	91000
BERRYPICKER	0.0004	1000000+	6300	25000
HUNTER	0.0002	1000000+	16000	64000
FISHERMAN	0.0001	1000000+	18000	72000
RESIDENT	0.0003	1000000+	8000	32000

[a] The plus sign (+) means "greater than."

Table C-104

Margins of Safety for Exposed Members of the Public
Aerial Routine-Worst Case Scenario
Triclopyr Sprayed on 400 acres by Fixed Wing

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (630.0)	SYSTEMIC NOEL (2.50)	REPRODUCTIVE NOEL (10.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0340	19000	74	290
VEGETATION CONTACT				
HIKER	0.0005	1000000+[a]	5100	21000
PICKER	0.0876	7200	29	110
DRINKING WATER	0.0254	25000	99	390
EATING BERRIES	0.0208	30000	120	480
EATING VEGETS.	0.0417	15000	60	240
EATING DEER	0.0033	190000	770	3100
EATING BIRD	0.0142	44000	180	700
EATING FISH	0.0101	62000	250	990
For Combined Routes of Exposure				
HIKER	0.0598	11000	42	170
BERRYPICKER	0.1677	3800	15	60
HUNTER	0.0773	8200	32	130
FISHERMAN	0.0700	9000	36	140
RESIDENT	0.1015	6200	25	99

[a] The plus sign (+) means "greater than."

Table C-105

Margins of Safety for Exposed Members of the Public
Backpack Routine-Worst Case Scenario
Triclopyr Sprayed on 60 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (630.0)	SYSTEMIC NOEL (2.50)	REPRODUCTIVE NOEL (10.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0014	460000	1800	7300
VEGETATION CONTACT				
HIKER	0.0000	1000000+[a]	130000	510000
PICKER	0.0035	180000	710	2800
DRINKING WATER	0.0008	820000	3300	13000
EATING BERRIES	0.0015	430000	1700	6800
EATING VEGETS.	0.0029	210000	850	3400
EATING DEER	0.0002	1000000+	13000	52000
EATING BIRD	0.0006	1000000	4100	16000
EATING FISH	0.0003	1000000+	8200	33000
For Combined Routes of Exposure				
HIKER	0.0022	290000	1200	4600
BERRYPICKER	0.0071	88000	350	1400
HUNTER	0.0030	210000	850	3400
FISHERMAN	0.0025	260000	1000	4100
RESIDENT	0.0051	120000	490	2000

[a] The plus sign (+) means "greater than."

Table C-106

Margins of Safety for Exposed Members of the Public
Right of Way Routine-Worst Case Scenario
Triclopyr Sprayed on 40 acres

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (630.0)	SYSTEMIC NOEL (2.50)	REPRODUCTIVE NOEL (10.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0005	1000000+[a]	5200	21000
VEGETATION CONTACT				
HIKER	0.0000	1000000+	360000	1000000+
PICKER	0.0012	510000	2000	8100
DRINKING WATER	0.0004	1000000+	6300	25000
EATING BERRIES	0.0006	1000000	4000	16000
EATING VEGETS.	0.0012	510000	2000	8100
EATING DEER	0.0001	1000000+	32000	130000
EATING BIRD	0.0002	1000000+	11000	45000
EATING FISH	0.0002	1000000+	16000	63000
For Combined Routes of Exposure				
HIKER	0.0009	710000	2800	11000
BERRYPICKER	0.0027	230000	910	3700
HUNTER	0.0012	530000	2100	8400
FISHERMAN	0.0010	600000	2400	9600
RESIDENT	0.0021	300000	1200	4700

[a] The plus sign (+) means "greater than."

Table C-107

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Amitrole

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4080.0)	SYSTEMIC NOEL (0.03)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0033	1000000+[a]	7.5	1500
VEGETATION CONTACT				
HIKER	0.0000	1000000+	520	100000
PICKER	0.0086	470000	2.9	580
DRINKING WATER	0.1174	35000	-4.7	43
EATING BERRIES	0.0932	44000	-3.7	54
EATING VEGETS.	0.1935	21000	-7.7	26
EATING DEER	0.0187	220000	1.3	270
EATING BIRD	0.1161	35000	-4.6	43
EATING FISH	0.0470	87000	-1.9	110
For Combined Routes of Exposure:				
HIKER	0.1208	34000	-4.8	41
BERRYPICKER	0.2225	18000	-8.9	22
HUNTER	0.2556	16000	-10	20
FISHERMAN	0.1677	24000	-6.7	30
RESIDENT	0.3143	13000	-13	16

[a] The plus sign (+) means "greater than."

Table C-108

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Asulam

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4000.0)	SYSTEMIC NOEL (50.00)	REPRODUCTIVE NOEL (50.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.2085	19000	240	240
VEGETATION CONTACT				
HIKER	0.0030	1000000+[a]	17000	17000
PICKER	0.5376	7400	93	93
DRINKING WATER	0.0734	55000	680	680
EATING BERRIES	0.0582	69000	860	860
EATING VEGETS.	0.1210	33000	410	410
EATING DEER	0.0131	310000	3800	3800
EATING BIRD	0.0827	48000	600	600
EATING FISH	0.0293	140000	1700	1700
For Combined Routes of Exposure:				
HIKER	0.2849	14000	180	180
BERRYPICKER	0.8777	4600	57	57
HUNTER	0.3807	11000	130	130
FISHERMAN	0.3142	13000	160	160
RESIDENT	0.4059	9900	120	120

[a] The plus sign (+) means "greater than."

Table C-109

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Atrazine

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1869.0)	SYSTEMIC NOEL (3.70)	REPRODUCTIVE NOEL (100.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.3545	5300	10	280
VEGETATION CONTACT				
HIKER	0.0051	370000	730	20000
PICKER	0.9139	2000	4.0	110
DRINKING WATER	0.1247	15000	30	800
EATING BERRIES	0.0990	19000	37	1000
EATING VEGETS.	0.2056	9100	18	490
EATING DEER	0.0222	84000	170	4500
EATING BIRD	0.1406	13000	26	710
EATING FISH	0.2494	7500	15	400
For Combined Routes of Exposure				
HIKER	0.4843	3900	7.6	210
BERRYPICKER	1.4922	1300	2.5	67
HUNTER	0.6471	2900	5.7	150
FISHERMAN	0.7337	2500	5.0	140
RESIDENT	0.6900	2700	5.4	140

Table C-110

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Bromacil

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (3998.0)	SYSTEMIC NOEL (6.25)	REPRODUCTIVE NOEL (7.92)
For Single Route of Exposure				
DERMAL, SPRAY	0.4171	9600	15	19
VEGETATION CONTACT				
HIKER	0.0060	670000	1000	1300
PICKER	1.0752	3700	5.8	7.4
DRINKING WATER	0.1467	27000	43	54
EATING BERRIES	0.1165	34000	54	68
EATING VEGETS.	0.2419	17000	26	33
EATING DEER	0.0261	150000	240	300
EATING BIRD	0.1654	24000	38	48
EATING FISH	0.0587	68000	110	130
For Combined Routes of Exposure:				
HIKER	0.5698	7000	11	14
BERRYPICKER	1.7555	2300	3.6	4.5
HUNTER	0.7613	5300	8.2	10
FISHERMAN	0.6285	6400	9.9	13
RESIDENT	0.8117	4900	7.7	9.8

Table C-111

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with 2,4-D

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (375.0)	SYSTEMIC NOEL (1.00)	REPRODUCTIVE NOEL (25.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.1026	3700	9.7	48
VEGETATION CONTACT				
HIKER	0.0015	250000	680	3400
PICKER	0.2645	1400	3.8	19
DRINKING WATER	0.0602	6200	17	84
EATING BERRIES	0.0478	7900	21	100
EATING VEGETS.	0.0992	3800	10	50
EATING DEER	0.0103	37000	97	480
EATING BIRD	0.0645	5800	16	78
EATING FISH	0.0241	16000	42	200
For Combined Routes of Exposure				
HIKER	0.1642	2300	6.1	30
BERRYPICKER	0.4750	790	2.1	11
HUNTER	0.2390	1600	4.2	20
FISHERMAN	0.1883	2000	5.3	26
RESIDENT	0.2634	1400	3.8	19

Table C-112

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with 2,4-DP

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (532.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (6.25)
For Single Route of Exposure				
DERMAL, SPRAY	0.1335	4000	37	47
VEGETATION CONTACT				
HIKER	0.0019	280000	2600	3300
PICKER	0.3441	1500	15	18
DRINKING WATER	0.0734	7300	68	85
EATING BERRIES	0.0582	9100	86	110
EATING VEGETS.	0.1210	4400	41	52
EATING DEER	0.0126	42000	400	500
EATING BIRD	0.0790	6700	63	79
EATING FISH	0.0293	18000	170	210
For Combined Routes of Exposure:				
HIKER	0.2087	2500	24	30
BERRYPICKER	0.6091	870	8.2	10
HUNTER	0.3003	1800	17	21
FISHERMAN	0.2381	2200	21	26
RESIDENT	0.3297	1600	15	19

Table C-113

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Dalapon

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (7577.0)	SYSTEMIC NOEL (15.00)	REPRODUCTIVE NOEL (300.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.4171	18000	36	720
VEGETATION CONTACT				
HIKER	0.0060	1000000+[a]	2500	50000
PICKER	1.0752	7000	14	280
DRINKING WATER	0.1467	52000	100	2000
EATING BERRIES	0.1165	65000	130	2600
EATING VEGETS.	0.2419	31000	62	1200
EATING DEER	0.0261	290000	570	11000
EATING BIRD	0.1654	46000	91	1800
EATING FISH	0.0587	130000	260	5100
For Combined Routes of Exposure				
HIKER	0.5698	13000	26	530
BERRYPICKER	1.7555	4300	8.5	170
HUNTER	0.7613	10000	20	390
FISHERMAN	0.6285	12000	24	480
RESIDENT	0.8117	9300	18	370

[a] The plus sign (+) means "greater than."

Table C-114

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Dicamba

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (757.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (2.50)
For Single Route of Exposure				
DERMAL, SPRAY	0.0834	9100	300	30
VEGETATION CONTACT				
HIKER	0.0012	630000	21000	2100
PICKER	0.2150	3500	120	12
DRINKING WATER	0.0587	13000	430	43
EATING BERRIES	0.0466	16000	540	54
EATING VEGETS.	0.0968	7800	260	26
EATING DEER	0.0099	76000	2500	250
EATING BIRD	0.0621	12000	400	40
EATING FISH	0.0235	32000	1100	110
For Combined Routes of Exposure				
HIKER	0.1433	5300	170	17
BERRYPICKER	0.4037	1900	62	6.2
HUNTER	0.2153	3500	120	12
FISHERMAN	0.1668	4500	150	15
RESIDENT	0.2401	3200	100	10

Table C-115

Margins of Safety for Exposed Members of the Public
Accidental-Worst Case Spraying with Diuron

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (3750.0)	SYSTEMIC NOEL (0.63)	REPRODUCTIVE NOEL (6.25)
For Single Route of Exposure				
DERMAL, SPRAY	0.6673	5600	-1.1	9.4
VEGETATION CONTACT				
HIKER	0.0096	390000	65	650
PICKER	1.7203	2200	-2.8	3.6
DRINKING WATER	0.2348	16000	2.7	27
EATING BERRIES	0.1864	20000	3.4	34
EATING VEGETS.	0.3871	9700	1.6	16
EATING DEER	0.0418	90000	15	150
EATING BIRD	0.2647	14000	2.4	24
EATING FISH	1.8780	2000	-3.0	3.3
For Combined Routes of Exposure				
HIKER	0.9117	4100	-1.5	6.9
BERRYPICKER	2.8088	1300	-4.5	2.2
HUNTER	1.2181	3100	-1.9	5.1
FISHERMAN	2.7897	1300	-4.5	2.2
RESIDENT	1.2987	2900	-2.1	4.8

Table C-116

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Fosamine

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (24400.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (500.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.5005	49000	50	1000
VEGETATION CONTACT				
HIKER	0.0072	1000000+[a]	3500	66000
PICKER	1.2902	19000	19	390
DRINKING WATER	0.1761	140000	140	2900
EATING BERRIES	0.1398	170000	180	3600
EATING VEGETS.	0.2903	84000	86	1700
EATING DEER	0.0313	780000	800	160000
EATING BIRD	0.1985	120000	130	2500
EATING FISH	0.0704	350000	350	7300
For Combined Routes of Exposure				
HIKER	0.6838	36000	37	730
BERRYPICKER	2.1066	12000	12	240
HUNTER	0.9136	27000	27	550
FISHERMAN	0.7542	32000	33	660
RESIDENT	0.9741	25000	26	510

[a] The plus sign (+) means "greater than."

Table C-117

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Glyphosate

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4320.0)	SYSTEMIC NOEL (31.00)	REPRODUCTIVE NOEL (10.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.2085	21000	150	48
VEGETATION CONTACT				
HIKER	0.0030	1000000+[a]	11000	3300
PICKER	0.5376	8000	58	19
DRINKING WATER	0.0734	59000	430	140
EATING BERRIES	0.0582	74000	540	170
EATING VEGETS.	0.1210	36000	260	83
EATING DEER	0.0131	330000	2400	770
EATING BIRD	0.0827	52000	370	120
EATING FISH	0.0293	150000	1000	340
For Combined Routes of Exposure				
HIKER	0.2849	15000	110	35
BERRYPICKER	0.8777	4900	35	11
HUNTER	0.3807	11000	82	26
FISHERMAN	0.3142	14000	99	32
RESIDENT	0.4059	11000	77	25

[a] The plus sign (+) means "greater than."

Table C-118

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Hexazinone

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1690.0)	SYSTEMIC NOEL (10.00)	REPRODUCTIVE NOEL (125.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.2503	6800	40	500
VEGETATION CONTACT				
HIKER	0.0036	470000	2800	35000
PICKER	0.6451	2600	16	190
DRINKING WATER	0.0880	19000	110	1400
EATING BERRIES	0.0699	24000	140	1800
EATING VEGETS.	0.1452	12000	69	860
EATING DEER	0.0157	110000	640	8000
EATING BIRD	0.0993	17000	100	1300
EATING FISH	0.0352	48000	280	3500
For Combined Routes of Exposure				
HIKER	0.3419	4900	29	370
BERRYPICKER	1.0533	1600	9.5	120
HUNTER	0.4568	3700	22	270
FISHERMAN	0.3771	4500	27	330
RESIDENT	0.4870	3500	21	260

Table C-119

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Picloram

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (8200.0)	SYSTEMIC NOEL (7.00)	REPRODUCTIVE NOEL (50.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.0100	820000	700	5000
VEGETATION CONTACT				
HIKER	0.0001	1000000+[a]	49000	350000
PICKER	0.0258	320000	270	1900
DRINKING WATER	0.0734	110000	95	680
EATING BERRIES	0.0582	140000	120	860
EATING VEGETS.	0.1210	68000	58	410
EATING DEER	0.0118	700000	590	4200
EATING BIRD	0.0729	110000	96	690
EATING FISH	0.0293	280000	240	1700
For Combined Routes of Exposure:				
HIKER	0.0835	98000	84	600
BERRYPICKER	0.1674	49000	42	300
HUNTER	0.1682	49000	42	300
FISHERMAN	0.1129	73000	62	440
RESIDENT	0.2045	40000	34	240

[a] The plus sign (+) means "greater than."

Table C-120

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Simazine

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (5000.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (5.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.2085	24000	24	24
VEGETATION CONTACT				
HIKER	0.0030	1000000+[a]	1700	1700
PICKER	0.5376	9300	9.3	9.3
DRINKING WATER	0.0734	68000	68	68
EATING BERRIES	0.0582	86000	86	86
EATING VEGETS.	0.1210	41000	41	41
EATING DEER	0.0131	380000	380	380
EATING BIRD	0.0827	60000	60	60
EATING FISH	0.0293	170000	170	170
For Combined Routes of Exposure				
HIKER	0.2849	18000	18	18
BERRYPICKER	0.8777	5700	5.7	5.7
HUNTER	0.3807	13000	13	13
FISHERMAN	0.3142	16000	16	16
RESIDENT	0.4059	12000	12	12

[a] The plus sign (+) means "greater than."

Table C-121

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Tebuthiuron

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (644.0)	SYSTEMIC NOEL (12.50)	REPRODUCTIVE NOEL (90.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.2503	2600	50	360
VEGETATION CONTACT				
HIKER	0.0036	180000	3500	25000
PICKER	0.6451	1000	19	140
DRINKING WATER	0.0880	7300	140	1000
EATING BERRIES	0.0699	9200	180	1300
EATING VEGETS.	0.1452	4400	86	620
EATING DEER	0.0157	41000	800	5700
EATING BIRD	0.0993	6500	130	910
EATING FISH	0.3521	1800	35	260
For Combined Routes of Exposure				
HIKER	0.3419	1900	37	260
BERRYPICKER	1.0533	610	12	85
HUNTER	0.4568	1400	27	200
FISHERMAN	0.6940	930	18	130
RESIDENT	0.4870	1300	26	180

Table C-122

Margins of Safety for Exposed Members of the Public Accidental-Worst Case Spraying with Triclopyr

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (630.0)	SYSTEMIC NOEL (2.50)	REPRODUCTIVE NOEL (10.00)
For Single Route of Exposure				
DERMAL, SPRAY	0.3337	1900	7.5	30
VEGETATION CONTACT				
HIKER	0.0048	130000	520	2100
PICKER	0.8602	730	2.9	12
DRINKING WATER	0.1174	5400	21	85
EATING BERRIES	0.0932	6800	27	110
EATING VEGETS.	0.1935	3300	13	52
EATING DEER	0.0209	30000	120	480
EATING BIRD	0.1323	4800	19	76
EATING FISH	0.0470	13000	53	210
For Combined Routes of Exposure				
HIKER	0.4558	1400	5.5	22
BERRYPICKER	1.4044	450	1.8	7.1
HUNTER	0.6091	1000	4.1	16
FISHERMAN	0.5028	1300	5.0	20
RESIDENT	0.6494	970	3.8	15

MARGINS OF SAFETY FOR DOSES TO WORKERS AND THE PUBLIC FROM HERBICIDE SPILLS

Table C-123

Margins of Safety for Doses Due to Spills of Amitrole Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4080.0)	SYSTEMIC NOEL (0.03)	REPRODUCTIVE NOEL (5.00)
Spills onto Skin				
CONCENTRATE	1.2000	3400	-48	4.2
SPRAY MIX	0.2400	17000	-9.6	21
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	---	---	---	---
RESERVOIR, HELO	---	---	---	---
POND, TRUCK	1.4736	2800	-59	3.4
RESERV., TRUCK	0.0460	89000	-1.8	110

Table C-124

Margins of Safety for Doses Due to Spills of Asulam Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4000.0)	SYSTEMIC NOEL (50.00)	REPRODUCTIVE NOEL (50.00)
Spills onto Skin				
CONCENTRATE	240.0000	17	-4.8	-4.8
SPRAY MIX	20.0400	200	2.5	2.5
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	---	---	---	---
RESERVOIR, HELO	---	---	---	---
POND, TRUCK	1.2300	3300	49	41
RESERV., TRUCK	0.0384	100000	1600	1300

Table C-125

Margins of Safety for Doses Due to Spills of Atrazine Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1869.0)	SYSTEMIC NOEL (3.70)	REPRODUCTIVE NOEL (100.00)
Spills onto Skin				
CONCENTRATE	240.0000	7.8	-65	-2.4
SPRAY MIX	24.0000	78	-6.5	4.2
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	0.0737	25000	50	1400
RESERVOIR, HELO	0.0023	810000	1600	43000
POND, TRUCK	1.4730	1300	2.5	68
RESERV., TRUCK	0.0460	41000	80	2200

Table C-126

Margins of Safety for Doses Due to Spills of Bromacil
Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (3998.0)	SYSTEMIC NOEL (6.25)	REPRODUCTIVE NOEL (7.92)
Spills onto Skin				
CONCENTRATE	240.0000	17	-38	-30
SPRAY MIX	12.0000	330	-1.9	-1.5
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	---	---	---	---
RESERVOIR, HELO	---	---	---	---
POND, TRUCK	0.7365	5400	8.5	11
RESERV., TRUCK	0.0230	170000	270	340

Table C-127

Margins of Safety for Doses Due to Spills of 2,4-D
Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (375.0)	SYSTEMIC NOEL (1.00)	REPRODUCTIVE NOEL (5.00)
Spills onto Skin				
CONCENTRATE	144.0000	2.6	-140	-1.2
SPRAY MIX	14.4000	26	-14	0.34
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	0.0737	5100	14	68
RESERVOIR, HELO	0.0023	160000	430	2200
POND, TRUCK	1.4730	250	-1.5	3.4
RESERV., TRUCK	0.0460	8100	22	110

Table C-128

Margins of Safety for Doses Due to Spills of 2,4-DP
Accidental-Worst Case Scenario

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (532.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (6.25)
Spills onto Skin				
CONCENTRATE	230.4000	2.3	-46	-37
SPRAY MIX	9.6000	55	-1.9	-1.5
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	---	---	---	---
RESERVOIR, HELO	---	---	---	---
POND, TRUCK	0.9206	580	5.4	6.8
RESERV., TRUCK	0.0288	18000	170	220

Table C-129

Margins of Safety for Doses Due to Spills of Dalapon Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (7577.0)	SYSTEMIC NOEL (15.00)	REPRODUCTIVE NOEL (300.00)
Spills onto Skin				
CONCENTRATE	---	---	---	---
SPRAY MIX	60.0000	130	-4.0	5.0
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	---	---	---	---
RESERVOIR, HELO	---	---	---	---
POND, TRUCK	3.6825	2100	4.1	81
RESERV., TRUCK	0.1151	66000	130	2600

Table C-130

Margins of Safety for Doses Due to Spills of Dicamba
Accidental-Worst Case Scenario

	EXPOSURE (MG/KG/DAY)	MARGIN OF SAFETY RELATIVE TO LD_{50} (757.0)	 SYSTEMIC NOEL (25.00)	 REPRODUCTIVE NOEL (2.50)
Spills onto Skin				
CONCENTRATE	120.0000	6.3	-4.8	-48
SPRAY MIX	12.0000	63	2.1	-4.8
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	---	---	---	---
RESERVOIR, HELO	---	---	---	---
POND, TRUCK	1.4730	510	17	1.7
RESERV., TRUCK	0.0460	16000	540	54

Table C-131

Margins of Safety for Doses Due to Spills of Diuron Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (3750.0)	SYSTEMIC NOEL (0.63)	REPRODUCTIVE NOEL (6.25)
Spills onto Skin				
CONCENTRATE	240.0000	16	-380	-38
SPRAY MIX	19.2000	200	-31	-3.1
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	---	---	---	---
RESERVOIR, HELO	---	---	---	---
POND, TRUCK	1.1784	3200	-1.9	5.3
RESERV., TRUCK	0.0368	100000	17	170

Table C-132

Margins of Safety for Doses Due to Spills of Fosamine
Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (24400.0)	SYSTEMIC NOEL (25.00)	REPRODUCTIVE NOEL (500.00)
Spills onto Skin				
CONCENTRATE	240.0000	100	-9.6	2.1
SPRAY MIX	72.0000	340	-2.9	6.7
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	---	---	---	---
RESERVOIR, HELO	---	---	---	---
POND, TRUCK	4.4191	5500	5.7	110
RESERV., TRUCK	0.1381	180000	180	3600

Table C-133

Margins of Safety for Doses Due to Spills of Glyphosate Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (4320.0)	SYSTEMIC NOEL (31.00)	REPRODUCTIVE NOEL (10.00)
Spills onto Skin				
CONCENTRATE	180.0000	24	-6.2	-18
SPRAY MIX	30.0000	140	-1.0	-3.0
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	---	---	---	---
RESERVOIR, HELO	---	---	---	---
POND, TRUCK	1.8413	2300	34	5.4
RESERV., TRUCK	0.0575	75000	1000	170

Table C-134

Margins of Safety for Doses Due to Spills of Hexazinone Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (1690.0)	SYSTEMIC NOEL (10.00)	REPRODUCTIVE NOEL (125.00)
Spills onto Skin				
CONCENTRATE	120.0000	14	-12	1.0
SPRAY MIX	18.0000	94	-1.8	6.9
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	0.0552	31000	180	2300
RESERVOIR, HELO	0.0017	980000	5800	72000
POND, TRUCK	1.1048	1500	9.1	110
RESERV., TRUCK	0.0345	49000	290	3600

Table C-135

Margins of Safety for Doses Due to Spills of Picloram Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (8200.0)	SYSTEMIC NOEL (7.00)	REPRODUCTIVE NOEL (50.00)
Spills onto Skin				
CONCENTRATE	5.7600	1400	1.2	8.7
SPRAY MIX	1.4400	5700	4.9	35
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO.	0.0921	89000	76	540
RESERVOIR,HELO	0.0029	1000000+[a]	2400	17000
POND, TRUCK	1.8413	4500	3.8	27
RESERV.,TRUCK	0.0575	140000	120	870

[a] The plus sign (+) means "greater than."

Table C-136

Margins of Safety for Doses Due to Spills of Simazine
Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (5000.0)	SYSTEMIC NOEL (5.00)	REPRODUCTIVE NOEL (5.00)
Spills onto Skin				
CONCENTRATE	240.0000	21	-48	-48
SPRAY MIX	30.0000	170	-6.0	-6.0
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	---	---	---	---
RESERVOIR, HELO	---	---	---	---
POND, TRUCK	1.8413	2700	2.7	2.7
RESERV., TRUCK	0.0575	87000	87	87

Table C-137

Margins of Safety for Doses Due to Spills of Tebuthiuron Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (644.0)	SYSTEMIC NOEL (12.50)	REPRODUCTIVE NOEL (90.00)
Spills onto Skin				
CONCENTRATE	---	---	---	---
SPRAY MIX	36.0000	18	-2.9	2.5
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	---	---	---	---
RESERVOIR, HELO	---	---	---	---
POND, TRUCK	2.2095	290	5.7	41
RESERV., TRUCK	0.0690	9300	180	1300

Table C-138

Margins of Safety for Doses Due to Spills of Triclopyr Accidental-Worst Case Scenario

		MARGIN OF SAFETY RELATIVE TO		
	EXPOSURE (MG/KG/DAY)	LD_{50} (630.0)	SYSTEMIC NOEL (2.50)	REPRODUCTIVE NOEL (10.00)
Spills onto Skin				
CONCENTRATE	240.0000	2.6	-96	-24
SPRAY MIX	48.0000	13	-19	-4.8
Spills Into Bodies of Water (Drinking One Liter of Water)				
POND, HELO	0.1473	4300	17	68
RESERVOIR, HELO	0.0046	140000	540	2200
POND, TRUCK	2.9460	210	-1.2	3.4
RESERV., TRUCK	0.0921	6800	27	110

Table C-139

Lifetime Cancer Risk - Exposed Public
Small Backpack, 6.0 Acres, Routine-Realistic Scenario

	EXPOSURES PER LIFETIME	RISK FROM EXCLUSIVE USE OF: 2,4-D	2,4-DP	ASULAM	BROMACIL	PICLORAM	AMITROLE	GLYPHOSATE	ATRAZINE
FOR A SINGLE EXPOSURE									
DERMAL, SPRAY	1	1.09E-10	1.36E-09	2.10E-11	5.29E-11	4.94E-13	5.01E-10	1.61E-12	1.63E-09
VEGETATION CONTACT									
HIKER	1	1.57E-12	1.96E-11	3.02E-13	7.60E-13	7.09E-15	7.19E-12	2.31E-14	2.34E-11
PICKER	1	4.33E-10	5.40E-09	8.32E-11	2.10E-10	1.95E-12	1.98E-09	6.39E-12	6.45E-09
DRINKING WATER	1	1.70E-10	1.98E-09	1.96E-11	4.93E-11	9.59E-12	4.67E-08	1.50E-12	1.52E-09
EATING BERRIES	1	3.13E-10	3.66E-09	3.61E-11	9.10E-11	1.77E-11	8.61E-08	2.77E-12	2.80E-09
EATING VEGETS.	1	6.26E-10	7.32E-09	7.23E-11	1.82E-10	3.54E-11	1.72E-07	5.55E-12	5.60E-09
EATING DEER	1	4.01E-11	4.69E-10	4.71E-12	1.18E-11	2.20E-12	1.07E-08	3.61E-13	3.65E-10
EATING FISH	1	6.79E-11	7.94E-10	7.84E-12	1.97E-11	3.83E-12	1.87E-08	6.01E-13	3.04E-09
Combined Routes of Exposure									
HIKER	1	2.81E-10	3.37E-09	4.09E-11	1.03E-10	1.01E-11	4.72E-08	3.14E-12	3.17E-09
BERRYPICKER	1	1.03E-09	1.24E-08	1.60E-10	4.03E-10	2.97E-11	1.35E-07	1.23E-11	1.24E-08
HUNTER	1	4.41E-10	5.24E-09	6.01E-11	1.51E-10	1.86E-11	8.86E-08	4.61E-12	4.66E-09
FISHERMAN	1	3.49E-10	4.16E-09	4.88E-11	1.23E-10	1.39E-11	6.59E-08	3.74E-12	6.21E-09
RESIDENT	1	9.07E-10	1.07E-08	1.13E-10	2.85E-10	4.55E-11	2.19E-07	8.68E-12	8.78E-09
FOR 30 EXPOSURES									
DERMAL, SPRAY	30	3.28E-09	4.09E-08	6.31E-10	1.59E-09	1.48E-11	1.50E-08	4.84E-11	4.89E-08
VEGETATION CONTACT									
HIKER	30	4.71E-11	5.87E-10	9.05E-12	2.28E-11	2.13E-13	2.16E-10	6.94E-13	7.02E-10
PICKER	30	1.30E-08	1.62E-07	2.50E-09	6.29E-09	5.86E-11	5.95E-08	1.92E-10	1.94E-07
DRINKING WATER	30	5.09E-09	5.95E-08	5.88E-10	1.48E-09	2.88E-10	1.40E-06	4.51E-11	4.56E-08
EATING BERRIES	30	9.40E-09	1.10E-07	1.08E-09	2.73E-09	5.31E-10	2.58E-06	8.32E-11	8.41E-08
EATING VEGETS.	30	1.88E-08	2.20E-07	2.17E-09	5.46E-09	1.06E-09	5.17E-06	1.66E-10	1.68E-07
EATING DEER	30	1.20E-09	1.41E-08	1.41E-10	3.55E-10	6.61E-11	3.22E-07	1.08E-11	1.09E-08
EATING FISH	30	2.04E-09	2.38E-08	2.35E-10	5.92E-10	1.15E-10	5.60E-07	1.80E-11	9.11E-08
Combined Routes of Exposure									
HIKER	30	8.42E-09	1.01E-07	1.23E-09	3.09E-09	3.03E-10	1.42E-06	9.42E-11	9.52E-08
BERRYPICKER	30	3.08E-08	3.72E-07	4.80E-09	1.21E-08	8.92E-10	4.06E-06	3.68E-10	3.72E-07
HUNTER	30	1.32E-08	1.57E-07	1.80E-09	4.54E-09	5.59E-10	2.66E-06	1.38E-10	1.40E-07
FISHERMAN	30	1.05E-08	1.25E-07	1.46E-09	3.68E-09	4.18E-10	1.98E-06	1.12E-10	1.86E-07
RESIDENT	30	2.72E-08	3.21E-07	3.40E-09	8.55E-09	1.36E-09	6.58E-06	2.61E-10	2.63E-07

Table C-140

Lifetime Cancer Risk - Exposed Public
Large Backpack, 60 Acres, Routine-Worst Case

	EXPOSURES PER LIFETIME	RISK FROM EXCLUSIVE USE OF:							
		2,4-D	2,4-DP	ASULAM	BROMACIL	PICLORAM	AMITROLE	GLYPHOSATE	ATRAZINE
FOR A SINGLE EXPOSURE									
DERMAL, SPRAY	1	4.21E-10	5.64E-09	1.13E-10	2.55E-10	3.80E-12	2.41E-09	1.03E-11	4.18E-09
VEGETATION CONTACT									
HIKER	1	6.04E-12	8.09E-11	1.62E-12	3.66E-12	5.45E-14	3.46E-11	1.48E-13	6.00E-11
PICKER	1	1.08E-09	1.45E-08	2.90E-10	6.57E-10	9.80E-12	6.21E-09	2.67E-11	1.08E-08
DRINKING WATER	1	3.91E-10	4.91E-09	6.28E-11	1.42E-10	4.42E-11	1.34E-07	5.77E-12	2.33E-09
EATING BERRIES	1	7.55E-10	9.49E-09	1.21E-10	2.74E-10	8.52E-11	2.59E-07	1.11E-11	4.50E-09
EATING VEGETS.	1	1.51E-09	1.90E-08	2.42E-10	5.48E-10	1.70E-10	5.19E-07	2.23E-11	9.00E-09
EATING DEER	1	9.73E-11	1.22E-09	1.59E-11	3.60E-11	1.07E-11	3.25E-08	1.46E-12	5.91E-10
EATING FISH	1	1.56E-10	1.97E-09	2.51E-11	5.68E-11	1.77E-11	5.38E-08	2.31E-12	4.66E-09
Combined Routes of Exposure									
HIKER	1	8.18E-10	1.06E-08	1.77E-10	4.00E-10	4.80E-11	1.37E-07	1.63E-11	6.58E-09
BERRYPICKER	1	2.65E-09	3.46E-08	5.87E-10	1.33E-09	1.43E-10	4.02E-07	5.39E-11	2.18E-08
HUNTER	1	1.21E-09	1.56E-08	2.43E-10	5.50E-10	9.02E-11	2.65E-07	2.23E-11	9.03E-09
FISHERMAN	1	9.74E-10	1.26E-08	2.02E-10	4.57E-10	6.57E-11	1.91E-07	1.86E-11	1.12E-08
RESIDENT	1	2.33E-09	2.96E-08	4.19E-10	9.49E-10	2.18E-10	6.56E-07	3.85E-11	1.56E-08
FOR 30 EXPOSURES									
DERMAL, SPRAY	30	1.26E-08	1.69E-07	3.38E-09	7.64E-10	1.14E-10	7.23E-08	3.10E-10	1.26E-07
VEGETATION CONTACT									
HIKER	30	1.81E-10	2.43E-09	4.85E-11	1.10E-10	1.64E-12	1.04E-09	4.45E-12	1.80E-09
PICKER	30	3.25E-08	4.36E-07	8.71E-09	1.97E-08	2.94E-10	1.86E-07	8.00E-10	3.24E-07
DRINKING WATER	30	1.17E-08	1.47E-07	1.88E-09	4.26E-09	1.32E-09	4.03E-06	1.73E-10	7.00E-08
EATING BERRIES	30	2.26E-08	2.85E-07	3.64E-09	8.22E-09	2.56E-09	7.78E-06	3.34E-10	1.35E-07
EATING VEGETS.	30	4.53E-08	5.69E-07	7.27E-09	1.64E-08	5.11E-09	1.56E-05	6.68E-10	2.70E-07
EATING DEER	30	2.92E-09	3.67E-08	4.77E-10	1.08E-09	3.21E-10	9.75E-07	4.39E-11	1.77E-08
EATING FISH	30	4.69E-09	5.90E-08	7.54E-10	1.70E-09	5.30E-10	1.61E-06	6.92E-11	140E-07
Combined Routes of Exposure									
HIKER	30	2.45E-08	3.19E-07	5.31E-09	1.20E-08	1.44E-09	4.11E-06	4.88E-10	1.97E-07
BERRYPICKER	30	7.96E-08	1.04E-06	1.76E-08	3.98E-08	4.29E-09	1.21E-05	1.62E-09	6.54E-07
HUNTER	30	3.64E-08	4.69E-07	7.29E-09	1.65E-08	2.71E-09	7.95E-06	6.70E-10	2.71E-07
FISHERMAN	30	2.92E-08	3.78E-07	6.07E-09	1.37E-08	1.97E-09	5.72E-06	5.57E-10	2.37E-07
RESIDENT	30	6.98E-08	8.88E-07	1.26E-08	2.85E-08	6.55E-09	1.97E-05	1.16E-09	4.67E-07

Table C-141

Lifetime Cancer Risk - Exposed Public
Small Right of Way, Routine-Realistic Scenario

	EXPOSURES PER LIFETIME				RISK FROM EXCLUSIVE USE OF:				
		2,4-D	2,4-DP	ASULAM	BROMACIL	PICLORAM	AMITROLE	GLYPHOSATE	ATRAZINE
FOR A SINGLE EXPOSURE									
DERMAL, SPRAY	1	2.65E-11	3.30E-10	8.15E-12	1.03E-11	9.57E-14	9.71E-11	4.17E-13	3.16E-10
VEGETATION CONTACT									
HIKER	1	3.80E-13	4.74E-12	1.17E-13	1.47E-13	1.37E-15	1.39E-12	5.98E-15	4.53E-12
PICKER	1	1.43E-10	1.79E-09	4.41E-11	5.55E-11	5.18E-13	5.25E-10	2.25E-12	1.71E-09
DRINKING WATER	1	9.52E-11	1.11E-09	1.76E-11	2.21E-11	4.30E-12	2.09E-08	8.99E-13	6.81E-10
EATING BERRIES	1	1.31E-10	1.53E-09	2.42E-11	3.04E-11	5.91E-12	2.88E-08	1.24E-12	9.36E-10
EATING VEGETS.	1	2.62E-10	3.06E-09	4.83E-11	6.08E-11	1.18E-11	5.76E-08	2.47E-12	1.87E-09
EATING DEER	1	1.61E-11	1.88E-10	3.01E-12	3.79E-12	7.10E-13	3.45E-09	1.54E-13	1.17E-10
EATING FISH	1	3.81E-11	4.45E-10	7.03E-12	8.85E-12	1.72E-12	8.38E-09	3.60E-13	1.36E-09
Combined Routes of Exposure									
HIKER	1	1.22E-10	1.45E-09	2.58E-11	3.25E-11	4.40E-12	2.10E-08	1.32E-12	1.00E-09
BERRYPICKER	1	3.96E-10	4.76E-09	9.40E-11	1.18E-10	1.08E-11	5.03E-08	4.81E-12	3.64E-09
HUNTER	1	1.80E-10	2.12E-09	3.68E-11	4.64E-11	6.87E-12	3.30E-08	1.88E-12	1.43E-09
FISHERMAN	1	1.60E-10	1.89E-09	3.29E-11	4.14E-11	6.12E-12	2.94E-08	1.68E-12	2.36E-09
RESIDENT	1	3.84E-10	4.51E-09	7.41E-11	9.34E-11	1.62E-11	7.86E-08	3.79E-12	2.87E-09
FOR 30 EXPOSURES									
DERMAL, SPRAY	30	7.94E-10	9.90E-09	2.44E-10	3.08E-10	2.87E-12	2.91E-09	1.25E-11	9.47E-09
VEGETATION CONTACT									
HIKER	30	1.14E-11	1.42E-10	3.51E-12	4.41E-12	4.12E-14	4.18E-11	1.79E-13	1.36E-10
PICKER	30	4.30E-09	5.36E-08	1.32E-09	1.67E-09	1.55E-11	1.58E-08	6.76E-11	5.13E-08
DRINKING WATER	30	2.86E-09	3.34E-08	5.27E-10	6.64E-10	1.29E-10	6.28E-07	2.70E-11	2.04E-08
EATING BERRIES	30	3.92E-09	4.59E-08	7.25E-10	9.12E-10	1.77E-10	8.63E-07	3.71E-11	2.81E-08
EATING VEGETS.	30	7.85E-09	9.18E-08	1.45E-09	1.82E-09	3.55E-10	1.73E-06	7.41E-11	5.62E-08
EATING DEER	30	4.82E-10	5.64E-09	9.03E-11	1.14E-10	2.13E-11	1.04E-07	4.62E-12	3.50E-09
EATING FISH	30	1.14E-09	1.34E-08	2.11E-10	2.66E-10	5.16E-11	2.51E-07	1.08E-11	4.09E-08
Combined Routes of Exposure									
HIKER	30	3.66E-09	4.34E-08	7.75E-10	9.76E-10	1.32E-10	6.31E-07	3.96E-11	3.01E-08
BERRYPICKER	30	1.19E-08	1.43E-07	2.82E-09	3.55E-09	3.25E-10	1.51E-06	1.44E-10	1.09E-07
HUNTER	30	5.39E-09	6.37E-08	1.11E-09	1.39E-09	2.06E-10	9.91E-07	5.65E-11	4.29E-08
FISHERMAN	30	4.80E-09	5.68E-08	9.86E-10	1.24E-09	1.84E-10	8.83E-07	5.04E-11	7.09E-08
RESIDENT	30	1.15E-08	1.35E-07	2.22E-09	2.80E-09	4.87E-10	2.36E-06	1.14E-10	8.62E-08

Table C-142

Lifetime Cancer Risk - Exposed Public
Large Right of Way, Routine-Worst Case

	EXPOSURES PER LIFETIME	RISK FROM EXCLUSIVE USE OF:							
		2,4-D	2,4-DP	ASULAM	BROMACIL	PICLORAM	AMITROLE	GLYPHOSATE	ATRAZINE
FOR A SINGLE EXPOSURE									
DERMAL, SPRAY	1	1.51E-10	2.30E-09	5.90E-11	8.92E-11	6.65E-13	1.35E-09	3.62E-12	3.11E-09
VEGETATION CONTACT									
HIKER	1	2.17E-12	3.29E-11	8.47E-13	1.28E-12	9.55E-15	1.94E-11	5.20E-14	4.46E-11
PICKER	1	3.89E-10	5.92E-09	1.52E-10	2.30E-10	1.72E-12	3.48E-09	9.34E-12	8.02E-09
DRINKING WATER	1	2.09E-10	2.98E-09	4.90E-11	7.40E-11	1.15E-11	1.12E-07	3.01E-12	2.58E-09
EATING BERRIES	1	3.25E-10	4.64E-09	7.63E-11	1.15E-10	1.79E-11	1.75E-07	4.68E-12	4.02E-09
EATING VEGETS.	1	6.51E-10	9.28E-09	1.53E-10	2.31E-10	3.58E-11	3.49E-07	9.37E-12	8.05E-09
EATING DEER	1	4.05E-11	5.78E-10	9.65E-12	1.46E-11	2.18E-12	2.12E-08	5.92E-13	5.09E-10
EATING FISH	1	8.36E-11	1.19E-09	1.96E-11	2.96E-11	4.60E-12	4.48E-08	1.20E-12	5.17E-09
Combined Routes of Exposure									
HIKER	1	3.62E-10	5.31E-09	1.09E-10	1.64E-10	1.22E-11	1.13E-07	6.68E-12	5.74E-09
BERRYPICKER	1	1.07E-09	1.58E-08	3.36E-10	5.08E-10	3.18E-11	2.91E-07	2.06E-11	1.77E-08
HUNTER	1	5.13E-10	7.47E-09	1.46E-10	2.20E-10	2.01E-11	1.90E-07	8.94E-12	7.68E-09
FISHERMAN	1	4.46E-10	6.50E-09	1.28E-10	1.94E-10	1.68E-11	1.58E-07	7.88E-12	1.09E-08
RESIDENT	1	1.01E-09	1.46E-08	2.61E-10	3.95E-10	4.80E-11	4.63E-07	1.60E-11	1.38E-08
FOR 30 EXPOSURES									
DERMAL, SPRAY	30	4.53E-09	6.89E-08	1.77E-09	2.68E-09	2.00E-11	4.05E-08	1.09E-10	9.33E-08
VEGETATION CONTACT									
HIKER	30	6.50E-11	9.88E-10	2.54E-11	3.84E-11	2.86E-13	5.81E-10	1.56E-12	1.34E-09
PICKER	30	1.17E-08	1.78E-07	4.56E-09	6.90E-09	5.15E-11	1.04E-07	2.80E-10	2.41E-07
DRINKING WATER	30	6.27E-09	8.94E-08	1.47E-09	2.22E-09	3.45E-10	3.36E-06	9.02E-11	7.75E-08
EATING BERRIES	30	9.76E-09	1.39E-07	2.29E-09	3.46E-09	5.38E-10	5.24E-06	1.40E-10	1.21E-07
EATING VEGETS.	30	1.95E-08	2.78E-07	4.58E-09	6.92E-09	1.08E-09	1.05E-05	2.81E-10	2.41E-07
EATING DEER	30	1.22E-09	1.74E-08	2.90E-10	4.38E-10	6.55E-11	6.36E-07	1.78E-11	1.53E-08
EATING FISH	30	2.51E-09	3.57E-08	5.88E-10	8.88E-10	1.38E-10	1.35E-06	3.61E-11	1.55E-07
Combined Routes of Exposure									
HIKER	30	1.09E-08	1.59E-07	3.27E-09	4.93E-09	3.66E-10	3.40E-06	2.00E-10	1.72E-07
BERRYPICKER	30	3.22E-08	4.75E-07	1.01E-08	1.53E-08	9.54E-10	8.74E-06	6.19E-10	5.32E-07
HUNTER	30	1.54E-08	2.24E-07	4.37E-09	6.60E-09	6.03E-10	5.70E-06	2.68E-10	2.30E-07
FISHERMAN	30	1.34E-08	1.95E-07	3.85E-09	5.82E-09	5.04E-10	4.75E-06	2.37E-10	3.27E-07
RESIDENT	30	3.04E-08	4.38E-07	7.84E-09	1.19E-08	1.44E-09	1.39E-05	4.81E-10	4.14E-07

Table C-143

Lifetime Cancer Risk - Exposed Public
Accidental-Worst Case Spraying

	EXPOSURES PER LIFETIME				RISK FROM EXCLUSIVE USE OF:				
		2,4-D	2,4-DP	ASULAM	BROMACIL	PICLORAM	AMITROLE	GLYPHOSATE	ATRAZINE
FOR A SINGLE EXPOSURE									
DERMAL, SPRAY	1	1.05E-07	1.60E-06	4.11E-08	6.20E-08	1.16E-09	9.39E-07	2.52E-09	2.16E-06
VEGETATION CONTACT									
HIKER	1	1.51E-09	2.29E-08	5.89E-10	8.90E-10	1.66E-11	1.35E-08	3.61E-11	3.11E-08
PICKER	1	2.71E-07	4.12E-06	1.06E-07	1.60E-07	2.98E-09	2.42E-06	6.50E-09	5.58E-06
DRINKING WATER	1	6.16E-08	8.78E-07	1.44E-08	2.18E-08	8.48E-09	3.30E-05	8.86E-10	7.61E-07
EATING BERRIES	1	4.89E-08	6.97E-07	1.15E-08	1.73E-08	6.73E-09	2.62E-05	7.04E-10	6.05E-07
EATING VEGETS.	1	1.02E-07	1.45E-06	2.38E-08	3.60E-08	1.40E-08	5.45E-05	1.46E-09	1.26E-06
EATING DEER	1	1.05E-08	1.50E-07	2.57E-09	3.88E-09	1.36E-09	5.28E-06	1.58E-10	1.36E-07
EATING FISH	1	2.46E-08	3.51E-07	5.78E-09	8.73E-09	3.39E-09	1.32E-05	3.55E-10	1.52E-06
Combined Routes of Exposure									
HIKER	1	1.68E-07	2.50E-06	5.61E-08	8.47E-08	9.65E-09	3.40E-05	3.44E-09	2.96E-06
BERRYPICKER	1	4.86E-07	7.29E-06	1.73E-07	2.61E-07	1.94E-08	6.26E-05	1.06E-08	9.11E-06
HUNTER	1	2.45E-07	3.59E-06	7.49E-08	1.13E-07	1.94E-08	7.19E-05	4.60E-09	3.95E-06
FISHERMAN	1	1.93E-07	2.85E-06	6.19E-08	9.35E-08	1.30E-08	4.72E-05	3.80E-09	4.48E-06
RESIDENT	1	2.70E-07	3.95E-06	7.99E-08	1.21E-07	2.36E-08	8.85E-05	4.90E-09	4.21E-06
FOR 30 EXPOSURES									
DERMAL, SPRAY	30	3.15E-06	4.79E-05	1.23E-06	1.86E-06	3.47E-08	2.82E-05	7.56E-08	6.49E-05
VEGETATION CONTACT									
HIKER	30	4.52E-08	6.87E-07	1.77E-08	2.67E-08	4.98E-10	4.04E-07	1.08E-09	9.32E-07
PICKER	30	8.12E-06	1.24E-04	3.18E-06	4.80E-06	8.95E-08	7.26E-05	1.95E-07	1.67E-04
DRINKING WATER	30	1.85E-06	2.63E-05	4.33E-07	6.55E-07	2.54E-07	9.91E-04	2.66E-08	2.28E-05
EATING BERRIES	30	1.47E-06	2.09E-05	3.44E-07	5.20E-07	2.02E-07	7.87E-04	2.11E-08	1.81E-05
EATING VEGETS.	30	3.05E-06	4.34E-05	7.14E-07	1.08E-06	4.19E-07	1.63E-03	4.38E-08	3.77E-05
EATING DEER	30	3.15E-07	4.51E-06	7.71E-08	1.16E-07	4.08E-08	1.58E-04	4.73E-09	4.07E-06
EATING FISH	30	7.39E-07	1.05E-05	1.73E-07	2.62E-07	1.02E-07	3.96E-04	1.06E-08	4.57E-05
Combined Routes of Exposure									
HIKER	30	5.04E-06	7.49E-05	1.68E-06	2.54E-06	2.90E-07	1.02E-03	1.03E-07	8.87E-05
BERRYPICKER	30	1.46E-05	2.19E-04	5.18E-06	7.83E-06	5.81E-07	1.88E-03	3.18E-07	2.73E-04
HUNTER	30	7.34E-06	1.08E-04	2.25E-06	3.40E-06	5.83E-07	2.16E-03	1.38E-07	1.19E-04
FISHERMAN	30	5.78E-06	8.55E-05	1.86E-06	2.80E-06	3.91E-07	1.42E-03	1.14E-07	1.34E-04
RESIDENT	30	8.09E-06	1.18E-04	2.40E-06	3.62E-06	7.09E-07	2.65E-03	1.47E-07	1.26E-04

Table C-144

Lifetime Cancer Risk - Exposure Due to Spills

	EXPOSURES PER LIFETIME	RISK FROM EXCLUSIVE USE OF:						
		2,4-D	2,4-DP	ASULAM	BROMACIL	PICLORAM	AMITROLE	GLYPHOSATE
FOR A SINGLE EXPOSURE								
SPILLS ONTO SKIN								
CONCENTRATE	1	1.47E-04	2.75E-03	4.72E-05	3.57E-05	6.66E-07	3.38E-04	2.17E-06
SPRAY MIX	1	1.47E-05	1.15E-04	3.95E-06	1.78E-06	1.66E-07	6.76E-05	3.62E-07
SPILLS INTO WATER (1 LITER DRUNK)								
POND, HELO	1	7.54E-08	----	----	----	1.06E-08	----	----
RESERV., HELO	1	2.36E-09	----	----	----	3.33E-10	----	----
POND, TRUCK	1	1.51E-06	1.10E-05	2.42E-07	1.10E-07	2.13E-07	4.15E-04	2.22E-08
RESERV., TRUCK	1	4.71E-08	3.44E-07	7.56E-09	3.42E-09	6.65E-09	1.30E-05	6.95E-10

APPENDIX I

SCIENTIFIC NAMES EQUIVALENT OF COMMON NAMES FOUND IN EIS TEXT

COMMON NAME	SCIENTIFIC NAME
Trees	
Alder	*Alnus* spp.
Aspen	*Populus tremuloides*
Big-leaf maple	*Acer macrophyllum*
Blue oak	*Quercus douglasii*
California bay	*Umbellularia californica*
California black oak	*Quercus kelloggii*
Canyon live oak	*Q. chrysolepis*
Chinquapin	*Chrysolepis chrysophylla*
Cottonwood	*Populus* ssp.
Digger pine	*Pinus sabiniana*
Douglas-fir	*Pseudotsuga menziesii*
Incense cedar	*Calocedrus decurrens*
Joshua tree	*Yucca brevifolia*
Live oak	*Quercus* spp.
Lodgepole pine	*Pinus murrayana*
Madrone	*Arbutus menziesii*
Mountain hemlock	*Tsuga mertensiana*
Oregon white oak	*Quercus garryana*
Pinyon pine	*Pinus monophylla*, *P. edulis*
Ponderosa pine	*P. ponderosa*
Red fir	*Abies magnifica*
Sugar pine	*Pinus lambertiana*
Tamarisk	*Tamarix* spp.
Tanoak	*Lithocarpus densiflora*
Western red cedar	*Thuja plicata*
Western juniper	*Juniperus occidentalis*
White fir	*Abies concolor*
Willow	*Salix* spp.
Yucca	*Yucca* spp.
Shrubs	
Big sagebrush	*Artemisia tridentata*
Bitterbrush	*Purshia tridentata*
Black brush	*Coleogyne ramosissma*
Black greasewood	*Sarcobatus vermiculatus*
Black sagebrush	*Artemisia nova*
Bud sagebrush	*Artemisia spinescens*
Cactus	*Opuntia* ssp., *Cereus* ssp., *Ferocactus* spp., *Echinocactus* spp., etc.
California sagebrush	*Artemisia californica*
Ceanothus	*Ceanothus* spp.
Chamise	*Adenostoma fasiculatum*
Cliffrose	*Cowania mexicana*
Coyote brush	*Baccharis pilularis* ssp. *consanguinea*
Creosote bush	*Larrea tridentata*
Ephedra	*Ephedra* spp.

Evergreen huckleberry	*Vaccinium ovatum*
Gray molly kochia	*Kochia california*
Greasewood	*Sarcobatus vermiculatus*
Horsebrush	*Tetradymia* spp.
Iodinebush	*Allenrolfea occidentalis*
Manzanita	*Arctostaphylos* spp.
Mountain mahogany	*Cercocarpus* spp.
Poison-oak	*Toxicodendron diversilobum*
Rabbitbrush	*Chrysothamnus* spp.
Sagebrush	*Artemisia* spp.
Saltbush	*Atriplex* spp.
Salvia	*Salvia* spp.
Scruboak	*Quercus* spp.
Shadscale	*Atriplex confertifolia*
Silver sagebrush	*Artemisia cana*
Snowberry	*Symphoricarpus* spp.
Spiny hopsage	*Grayia spinosa*
Spiny menodora	*Menodora spinescens*
White bursage	*Ambrosia dumosa*

Forbs, Grasses and Grasslike Plants

Alkali Sacaton	*Sporobolus airoides*
Bentgrass	*Agrostis* spp.
Bluebunch wheatgrass	*Agropyron spicatum*
Bluegrass	*Poa* spp.
Blue wildrye	*Elymus glaucus*
Bromes	*Bromus* spp.
Burclover	*Medicago polymorpha*
California oatgrass	*Danthonia californica*
Cattail	*Typha* spp.
Cheatgrass	*Bromus tectorum*
Clover	*Trifolium* spp.
Dalea	*Dalea* spp.
Desert needlegrass	*Stipa speciosa*
Fescue	*Festuca* spp.
Filaree	*Erodium* spp.
Galleta	*Hilaria jamesii*, *H. rigida*
Great Basin wildrye	*Elymus cinereus*
Idaho fescue	*Festuca idahoensis*
Indian rice grass	*Oryzopsis hymenoides*
Mountain brome	*Bromus marginatus*
Medusahead	*Taeniatherum asperum*
Needlegrass	*Stipa* spp.
Rush	*Juncus* spp.
Saltgrass	*Distichlis spicata*
Sedge	*Carex* spp.
Soft chess	*Bromus mollis*
Squirreltail	*Sitanion hystrix*
Tufted hairgrass	*Deschampsia caespitosa*
Velvet grass	*Holcus lanatus*
Western fescue	*Festuca occidentalis*
Wild barley	*Hordeum jubatum*
Wild oat	*Avena barbata*, *A. fatua*
Winterfat	*Eurotia lanata*

APPENDIX J

FEDERALLY LISTED, STATE-LISTED AND BLM SENSITIVE PLANT SPECIES WHICH OCCUR WITHIN THE EIS AREA

FEDERALLY LISTED ENDANGERED OR THREATENED PLANTS KNOWN TO OCCUR ON PUBLIC LANDS MANAGED BY THE BUREAU OF LAND MANAGEMENT IN CALIFORNIA

Scientific Name	Common Name	Family	Status 1/	District(s)
Arabis mcdonaldiana Eastw.	McDonald's rock-cress	Brassicaceae	E	Ukiah
Camissonia benitenis Raven	San Benito evening-primrose	Onagraceae	T	Bakersfield
Grindelia fraxino-pratensis Reveal & Beatley	Ash Meadows gum-plant	Asteraceae	T	California Desert
Oenothera avita Klein ssp. *eurekensis* (Munz & Roos) Klein	Eureka Valley evening-primrose	Onagraceae	E	California Desert
Nitrophila mohavensis Munz & Roos	Amargosa nitrewort	Chenopodiaceae	E	California Desert
Swallenia alexandrae (Swallen) Soderstrom & Decker	Eureka Dune grass	Poaceae	E	California Desert

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1/ Status: E = endangered; T = threatened.

STATE OF CALIFORNIA DESIGNATED ENDANGERED OR RARE PLANTS
KNOWN OR SUSPECTED TO OCCUR ON PUBLIC LANDS
MANAGED BY THE BUREAU OF LAND MANAGEMENT

Scientific Name	Common Name	Family	Status 1/	District(s) & Occurrence 2/
Acanthomintha ilicifolia (Gray) Gray	San Diego thornmint	Lamiaceae	E	California Desert (S)
Arabis mcdonaldiana Eastw.	McDonald's rock-cress	Brassicaceae	E	Ukiah (K)
Astragalus agnicidus Barneby	Humboldt milk-vetch	Fabaceae	E	Ukiah (K)
Astragalus johannis-howellii Barneby	Long Valley milk-vetch	Fabaceae	R	Bakersfield (K)
Astragalus lentiginosus Dougl. var. *sesquimetralis* (Rydb.) Barneby	Sodaville milk-vetch	Fabaceae	E	California Desert (K)
Astragalus magdalenae Greene var. *peirsonii* (Munz & McBurn.) Barneby	Peirson's milk-vetch	Fabaceae	E	California Desert (K)
Astragalus monoensis Barneby	Mono milk-vetch	Fabaceae	R	Bakersfield (K)
Bensoniella oregana (Abrams & Bacig.) Morton	Bensoniella	Saxifragaceae	R	Ukiah (S)
Bloomeria humilis Hoover	Dwarf golden star	Liliaceae (or Amaryllidaceae)	R	Bakersfield (S)
Brodiaea coronaria (Salisb.) Engler ssp. *rosea* (Greene) Niehaus	Indian Valley brodiaea	Liliaceae (or Amaryllidaceae)	E	Ukiah (K)
Brodiaea filifolia Wats.	Thread-leaved brodiaea	Liliaceae (or Amaryllidaceae)	E	California Desert (K)
Brodiaea insignis (Jeps.) Niehaus	Kaweah brodiaea	Liliaceae (or Amaryllidaceae)	E	Bakersfield (S)
Calamagrostis foliosa Kearn.	Leafy reed grass	Poaceae	R	Ukiah (K)
Calochortus dunnii Purdy	Dunn's mariposa	Liliaceae	R	California Desert (K)
Calochortus persistens Ownbey	Siskiyou mariposa	Liliaceae	R	Ukiah (S)
Calystegia stebbinsii Brummitt	Stebbins' morning glory	Convolvulaceae	E	Bakersfield (S)
Carex albida Bailey	White sedge	Cyperaceae	E	Ukiah (S)
Caulanthus stenocarpus Pays.	Slender-pod caulanthus	Brassicaceae	R	California Desert (K)
Ceanothus roderickii Knight	Pine Hill ceanothus; Roderick's buckbrush	Rhamnaceae	R	Bakersfield (S)
Cirsium ciliolatum (Hend.) J.T. Howell	Ashland thistle	Asteraceae	E	Ukiah (S)
Clarkia lingulata Lewis & Lewis	Merced Canyon clarkia	Onagraceae	R	Bakersfield (S)

Scientific Name	Common Name	Family	Status 1/	District(s) & Occurrence 2/
Cordylanthus nidularis J.T. Howell	Procumbent cordylanthus	Scrophulariaceae	R	Bakersfield (S)
Croton wigginsii Wheeler	Wiggins' croton	Euphorbiaceae	R	California Desert (K)
Dedeckera eurekensis Reveal & Howell	July gold	Polygonaceae	R	Bakersfield (K); California Desert (K)
Delphinium hesperium Gray ssp. cuyamacae (Abrams) Lewis & Epling	Cuyamaca larkspur	Ranunculaceae	R	California Desert (S)
Dichanthelium lanuginosum (Ell.) Gould var. thermale (Bol.) Spellenburg	Hot spring panic grass; Geyser's panicum	Poaceae	E	Ukiah (K)
Eriogonum apricum J.T. Howell var. apricum	Ione buckwheat	Polygonaceae	E	Bakersfield (K)
Eriogonum apricum J.T. Howell var. prostratum Myatt	Irish Hill buckwheat	Polygonaceae	R	Bakersfield (S)
Eriogonum ericifolium T. & G. var. thornei Reveal & Hendrickson	Thorne's buckwheat	Polygonaceae	E	California Desert (K)
Eriogonum kelloggii Gray	Red Mountain buckwheat	Polygonaceae	E	Ukiah (K)
Eryngium aristulatum Jeps. var. parishii (Coult. & Rose) Math. & Const.	San Diego coyote-thistle	Apiaceae	E	California Desert (S)
Erysimum menziesii (Hook.) Wettst.	Menzies wallflower	Brassicaceae	E	Ukiah (K)
Fremontodendron decumbens R. Lloyd	Pine Hill flannelbush	Sterculiaceae	R	Bakersfield (K)
Fremontodendron mexicanum A. Davids.	Mexican fremontia; Mexican flannelbrush	Sterculiaceae	R	California Desert (K)
Fritillaria roderickii Knight (= F. grayana)	Roderick's fritillary	Liliaceae	E	Ukiah (S)
Galium californicum H. & A. ssp. sierrae Dempster & Stebbins	El Dorado bedstraw	Rubiaceae	R	Bakersfield (K)
Gratiola heterosepala Mason & Bacig.	Boggs Lake hedge-hyssop	Scrophulariaceae	E	Susanville (K)
Helianthus niveus (Benth.) Bdg. ssp. tephrodes (Gray) Heiser	Desert sunflower; Algodones sunflower	Asteraceae	E	California Desert (K)
Hemizonia arida Keck	Red Rock tarweed	Asteraceae	R	California Desert (K)
Hemizonia conjugens Keck	Otay tarweed	Asteraceae	E	California Desert (K)

Scientific Name	Common Name	Family	Status 1/	District(s) & Occurrence 2/
Lasthenia burkei (Greene) Greene	Burke's goldfields	Asteraceae	E	Ukiah (S)
Limnanthes bakeri Howell	Baker's meadow foam	Limnanthaceae	R	Ukiah (S)
Limnanthes floccosa Howell ssp. californica Arroyo	Butte County meadow foam	Limnanthaceae	E	Ukiah (S)
Limnanthes gracilis Howell var. parishii (Jeps.) C. Mason	Parish's meadow foam	Limnanthaceae	E	California Desert (K)
Lupinus milo-bakeri C.P. Smith	Milo Baker's lupine	Fabaceae	R	Ukiah (S)
Machaeranthera lagunensis Keck	Laguna aster	Asteraceae	R	California Desert (K)
Nitrophila mohavensis Munz & Roos	Amargosa nitrophila	Chenopodiaceae	E	California Desert (K)
Nolina interrata Gentry	Dehesa nolina	Agavaceae	E	California Desert (K)
Oenothera avita Klein ssp. eurekensis (Munz & Roos) Klein	Eureka Dunes evening-primrose	Onagraceae	R	California Desert (K)
Orcuttia greenei Vasey (see Tuctoria greenei)				
Orcuttia pilosa Hoover	Hairy orcutt grass	Poaceae	E	Ukiah (S)
Orcuttia tenuis Hitchcock	Slender orcutt grass	Poaceae	E	Ukiah (K); Susanville (K)
Pleuropogon hooverianus (L. Benson) J.T. Howell	North Coast semaphore grass	Poaceae	R	Ukiah (S)
Pseudobahia bahiaefolia (Benth.) Rydb.	Hartweg's pseudobahia	Asteraceae	E	Bakersfield (S)
Sanicula saxatilis Greene	Rock sanicle	Apiaceae	R	Bakersfield (S)
Senecio layneae Greene	Layne's butterweed	Asteraceae	R	Bakersfield (K)
Sidalcea covillei Greene	Owens Valley checker-mallow	Malvaceae	E	Bakersfield (K)
Sidalcea hickmanii Greene ssp. anomala C.L. Hitchc.	Cuesta Pass checker-mallow	Malvaceae	R	Bakersfield (S)
Sidalcea hickmanii Greene ssp. parishii (Rob.) C.L. Hitchc.	Parish's checker-mallow	Malvaceae	R	Bakersfield (S)
Silene campanulata Wats. ssp. campanulata	Red Mountain campion	Caryophyllaceae	E	Ukiah (K)
Stipa lemmonii (Vasey) Scribn. var. pubescens Crampton	Crampton's spear grass	Poaceae	R	Ukiah (S)

Scientific Name	Common Name	Family	Status	District(s) & Occurrence 2/
Swallenia alexandrae (Swallen) Soderstrom & Decker	Eureka Dune grass	Poaceae	R	California Desert (K)
Tuctoria greenei (Vasey) J. Reeder (= *Orcuttia greenei* Vasey)	Greene's orcutt grass	Poaceae	R	Bakersfield (S); Ukiah (S)

1/ Status: E = endangered; R = rare.
2/ Occurrence: K = known to occur on public lands; S = suspected to occur on public lands.

SENSITIVE PLANTS
BUREAU OF LAND MANAGEMENT, CALIFORNIA

Scientific Name	Common Name	Family	Status 1/	District(s) & Occurrence 2/
Acanthomintha ilicifolia (Gray) Gray	San Diego thornmint	Lamiaceae	SC	California Desert (S)
Agrostis microphylla Steud. var. hendersonii (Hitchc.) Beetle	Henderson's bent grass	Poaceae	SC	Ukiah (S)
Allium sanbornii Wood var. tuolumnense Ownbey & Aase	Rawhide Hill onion	Liliaceae (or Amaryllidaceae)	SC	Bakersfield (K)
Alopecurus aequalis Sobol. var. sonomensis Rubtzoff	Sonoma alopecurus	Poaceae	SC	Ukiah (S)
Amsinckia furcata Suksd.	Green fiddleneck	Boraginaceae	SC	Bakersfield (K)
Antirrhinum ovatum Eastw.	Oval-leaved snapdragon	Scrophulariaceae	SB 3/	Bakersfield (K)
Arabis constancei Roll.	Constance's rock-cress	Brassicaceae	SC	Susanville (S)
Arctostaphylos otayensis Wies. & Schreib.	Otay manzanita	Ericaceae	SC	California Desert (K)
Arctostaphylos pilosula Jeps. & Wies. ssp. pilosula	Santa Margarita manzanita	Ericaceae	SC	Bakersfield (K)
Arctostaphylos rudis Jeps. & Wies.	Shagbark manzanita	Ericaceae	SC	Bakersfield (K)
Arctostaphylos uva-ursi (L.) Spreng. ssp. myrtifolia (Parry) Roof	Ione manzanita	Ericaceae	SC	Bakersfield (K)
Astragalus agnicidus Barneby	Humboldt milk-vetch	Fabaceae	SC	Ukiah (K)
Astragalus clarianus Jeps.	Napa milk-vetch	Fabaceae	SC	Ukiah (K)
Astragalus deanei (Rydb.) Barneby	Deane's milk-vetch	Fabaceae	SC	California Desert (K)
Astragalus douglasii (T.&G.) Gray var. perstrictus (Rydb.) Munz & McBurn.	Round-podded milk-vetch	Fabaceae	SC	California Desert (K)
Astragalus jaegerianus Munz	Coolgardie milk-vetch; Lane Mt. milk-vetch	Fabaceae	SC	California Desert (K)
Astragalus lentiginosus Dougl. var. coachellae Barneby	Coachella Valley milk-vetch	Fabaceae	SC	California Desert (K)
Astragalus lentiginosus Dougl. var. micans Barneby	Shiny milk-vetch	Fabaceae	SC	California Desert (K)
Astragalus lentiginosus Dougl. var. piscinensis Barneby	Fish Slough milk-vetch	Fabaceae	SC	Bakersfield (K)

Scientific Name	Common Name	Family	Status 1/	District(s) & Occurrence 2/
Astragalus lentiginosus Dougl. var. *sesquimetralis* (Rydb.) Barneby	Sodaville milk-vetch	Fabaceae	SC	California Desert (K)
Astragalus magdalenae Greene var. *peirsonii* (Munz & McBurn.) Barneby	Peirson's milk-vetch	Fabaceae	SC	California Desert (K)
Astragalus mohavensis Wats. var. *hemigyrus* (Clokey) Barneby	Darwin Mesa milk-vetch	Fabaceae	SC	California Desert (K)
Astragalus monoensis Barneby	Mono milk-vetch	Fabaceae	SC	Bakersfield (K)
Astragalus tegetarioides Jones	Deschutes milk-vetch	Fabaceae	SC	Susanville (K)
Atriplex patula L. ssp. *spicata* (Wats.) Hall & Clem.		Chenopodiaceae	SC	Bakersfield (S)
Atriplex vallicola Hoover	Lost Hills saltbush	Chenopodiaceae	SC	Bakersfield (K)
Bensoniella oregana (Abrams & Bacig.) Morton	Bensoniella	Saxifragaceae	SC	Ukiah (S)
Berberis nervosa Pursh var. *mendocinensis* Roof	Mendocino barberry	Berberidaceae	SC	Ukiah (S)
Berberis nevinii Gray	Nevin's barberry	Berberidaceae	SC	California Desert (S)
Bloomeria humilis Hoover	Dwarf golden star	Liliaceae (or Amaryllidaceae)	SC	Bakersfield (S)
Brodiaea coronaria (Salisb.) Engler ssp. *rosea* (Greene) Niehaus	Indian Valley brodiaea	Liliaceae (or Amaryllidaceae)	SC	Ukiah (K)
Brodiaea filifolia Wats.	Thread-leaved brodiaea	Liliaceae (or Amaryllidaceae)	SC	California Desert (K)
Brodiaea insignis (Jeps.) Niehaus	Kaweah brodiaea	Liliaceae (or Amaryllidaceae)	SC	Bakersfield (S)
Brodiaea orcuttii (Greene) Hoover	Orcutt's brodiaea	Liliaceae (or Amaryllidaceae)	SC	California Desert (K)
Calamagrostis crassiglumis Thurb.	Thurber's reed grass	Poaceae	SC	Ukiah (S)
Calochortus clavatus Wats. ssp. *recurvifolius* (Hoover) Munz	Arroyo de la Cruz mariposa	Liliaceae	SC	Bakersfield (S)
Calochortus dunnii Purdy	Dunn's mariposa	Liliaceae	SC	California Desert (K)
Calochortus excavatus Greene	Inyo mariposa	Liliaceae	SC	Bakersfield (K); California Desert (S)

Scientific Name	Common Name	Family	Status [1/]	District(s) & Occurrence [2/]
Calochortus monanthus Ownbey	Shasta River mariposa	Liliaceae	SC	Ukiah (S)
Calochortus persistens Ownbey	Siskiyou mariposa	Liliaceae	SC	Ukiah (S)
Calycadenia fremontii Gray	Fremont's calycadenia	Asteraceae	SC	Ukiah (K)
Calystegia stebbinsii Brummitt	Stebbins' morning glory	Convolvulaceae	SC	Bakersfield (S)
Camissonia hardhamiae Raven	Hardham's evening-primrose	Onagraceae	SC	Bakersfield (S)
Carex albida Bailey	White sedge	Cyperaceae	SC	Ukiah (S)
Castilleja latifolia H. & A. ssp. *mendocinensis* Eastw.	Mendocino Coast paintbrush	Scrophulariaceae	SC	Ukiah (S)
Castilleja mollis Penn.	Soft-leaved paintbrush	Scrophulariaceae	SC	Bakersfield (K)
Caulanthus californicus (Wats.) Pays.	California caulanthus	Brassicaceae	SC	Bakersfield (K)
Caulanthus simulans Pays.	Payson's caulanthus	Brassicaceae	SC	California Desert (S)
Caulanthus stenocarpus Pays.	Slender-pod caulanthus	Brassicaceae	SC	California Desert (K)
Caulostramina jaegeri (Rollins) Rollins	Jaeger's caulostramina	Brassicaceae	SC	California Desert (K); Bakersfield (S)
Ceanothus confusus J.T. Howell	Rincon ceanothus	Rhamnaceae	SC	Ukiah (S)
Ceanothus divergens Parry	Calistoga ceanothus	Rhamnaceae	SC	Ukiah (S)
Ceanothus ferrisae McMinn	Coyote ceanothus	Rhamnaceae	SC	Bakersfield (S)
Ceanothus hearstiorum Hoover & Roof	Hearst's ceanothus	Rhamnaceae	SC	Bakersfield (S)
Ceanothus roderickii Knight	Pine Hill ceanothus; Roderick's buckbrush	Rhamnaceae	SC	Bakersfield (S)
Centrostegia leptoceras (Gray) Wats.	Slender-horned spineflower	Polygonaceae	SP	California Desert (K)
Chaenactis parishii Gray	Parish's pincushion flower	Asteraceae	SC	California Desert (K)
Chamaesyce hooveri (Wheeler) Koutnik	Hoover's spurge	Euphorbiaceae	SC	Ukiah (S)
Chamaesyce platysperma (Engelm.) Koutnik	Flat-seeded spurge	Euphorbiaceae	SC	California Desert (K)
Chlorogalum grandiflorum Hoover	Red Hills soaproot	Liliaceae	SC	Bakersfield (K)
Chlorogalum purpureum Bdg. var. *purpureum*	Purple amole	Liliaceae	SC	Bakersfield (S)

Scientific Name	Common Name	Family	Status 1/	District(s) & Occurrence 2/
Chorizanthe breweri Wats.	Brewer's spineflower	Polygonaceae	SC	Bakersfield (S)
Chorizanthe howellii Goodm.	Howell's spineflower	Polygonaceae	SC	Ukiah (S)
Chorizanthe rectispina Goodm.	One-awned spineflower	Polygonaceae	SC	Bakersfield (S)
Cirsium ciliolatum (Hend.) J.T. Howell	Ashland thistle	Asteraceae	SC	Ukiah (S)
Cirsium fontinale (Greene) Jeps. var. campylon (H.L. Sharsm.) Turner & Pilz, ined.	Mt. Hamilton thistle	Asteraceae	SC	Bakersfield (S)
Cirsium fontinale (Greene) Jeps. var. obispoense J.T. Howell	Chorro Creek bog thistle	Asteraceae	SC	Bakersfield (S)
Cirsium loncholepis Petrak	La Graciosa thistle	Asteraceae	SC	Bakersfield (K)
Cirsium rhothophilum Blake	Surf thistle	Asteraceae	SC	Bakersfield (K)
Clarkia lingulata Lewis & Lewis	Merced Canyon clarkia	Onagraceae	SC	Bakersfield (S)
Clarkia mosquinii E. Small ssp. mosquinii	Mosquin's clarkia	Onagraceae	SC	Ukiah (S)
Clarkia rostrata W.S. Davis	Beaked clarkia	Onagraceae	SC	Bakersfield (S)
Collinsia antonina Hardham	San Antonio collinsia	Scrophulariaceae	SC	Bakersfield (K)
Collomia rawsoniana Greene	Flaming trumpet	Polemoniaceae	SC	Bakersfield (S)
Cordylanthus mollis Gray ssp. hispidus (Penn.) Chuang & Heckard	Hispid bird's beak	Scrophulariaceae	SC	Bakersfield (S)
Cordylanthus nidularius J.T. Howell	Procumbent cordylanthus	Scrophulariaceae	SC	Bakersfield (S)
Cordylanthus tecopensis Munz & Roos	Tecopa bird's beak	Scrophulariaceae	SC	California Desert (K)
Cordylanthus tenuis Gray ssp. pallescens (Penn.) Chuang & Heckard	Pallid bird's beak	Scrophulariaceae	SC	Ukiah (S)
Coreopsis hamiltonii (Elmer) H.K. Sharsm.	Mt. Hamilton coreopsis	Asteraceae	SC	Bakersfield (S)
Coryphantha vivipara (Nutt.) Britt. & Rose var. alversonii (Coult.) Benson	Alverson's pincushion cactus	Cactaceae	SC	California Desert (K)
Cryptantha crinita Greene	Silky cryptantha	Boraginaceae	SC	Ukiah (S)
Cupressus stephensonii C.B. Wolf	Cuyamaca cypress	Cupressaceae	SC	California Desert (S)
Delphinium hesperium Gray ssp. cuyamacae (Abrams) Lewis & Epling	Cuyamaca larkspur	Ranunculaceae	SC	California Desert (S)

Scientific Name	Common Name	Family	Status 1/	District(s) & Occurrence 2/
Dichanthelium lanuginosum (Ell.) Gould var. *thermale* (Bol.) Spellenburg	Hot spring panic grass; Geyser's panicum	Poaceae	SC	Ukiah (K)
Ditaxis californica (Bdg.) Pax & K. Hoffm.	California ditaxis	Euphorbiaceae	SC	California Desert (K)
Dithyrea maritima A. Davidson	Beach spectacle pod	Brassicaceae	SC	Bakersfield (K)
Dudleya saxosa (Jones) Britt. & Rose ssp. *saxosa*	Panamint live-forever	Crassulaceae	SC	California Desert (K)
Dudleya variegata (Wats.) Moran	Variegated dudleya	Crassulaceae	SC	California Desert (K)
Eatonella congdonii Gray	Congdon's eatonella	Asteraceae	SB 3/	Bakersfield (K)
Echinocereus engelmannii (Parry) Ruempler var. *howei* Benson	Howe's hedgehog cactus	Cactaceae	SC	California Desert (K)
Echinocereus engelmannii (Parry) Ruempler var. *munzii* Pierce & Fosb.	Munz's hedgehog cactus	Cactaceae	SC	California Desert (K)
Enceliopsis covillei (Nels.) Blake	Panamint daisy	Asteraceae	SC	California Desert (K)
Eremalche kernensis C.B. Wolf	Kern mallow	Malvaceae	SC	Bekrsfield (K)
Eriastrum brandegeae Mason	Brandegee's eriastrum	Polemoniaceae	SC	Ukiah (K)
Eriastrum densifolium ssp. *sanctorum* (Mlkn.) Mason	Santa Ana River eriastrum	Polemoniaceae	SP	California Desert (K)
Eriastrum hooveri (Jeps.) Mason	Hoover's eriastrum	Polemoniaceae	SC	Bakersfield (K)
Eriastrum tracyi Mason	Tracy's eriastrum	Polemoniaceae	SC	Ukiah (K)
Erigeron parishii Gray	Parish's daisy	Asteraceae	SC	California Desert (K)
Eriogonum ampullaceum J.T. Howell	Mono buckwheat	Polygonaceae	SC	Bakersfield (K)
Eriogonum apricum J.T. Howell var. *apricum*	Ione buckwheat	Polygonaceae	SC	Bakersfield (K)
Eriogonum apricum J.T. Howell var. *prostratum* Myatt	Irish Hill buckwheat	Polygonaceae	SC	Bakersfield (S)
Eriogonum bifurcatum Reveal	Forked buckwheat	Polygonaceae	SC	California Desert (K)
Eriogonum breedlovei (J.T. Howell) Reveal var. *breedlovei*	Piute buckwheat	Polygonaceae	SC	Bakersfield (S)
Eriogonum crosbyae Reveal	Crosby's buckwheat	Polygonaceae	SC	Susanville (K)

Scientific Name	Common Name	Family	Status 1/	District(s) & Occurrence 2/
Eriogonum eremicola J.T. Howell & Reveal	Wild Rose Canyon buckwheat	Polygonaceae	SC	California Desert (K); Bakersfield (K)
Eriogonum ericifolium T. & G. var. thornei Reveal & Hendrickson	Thorne's buckwheat	Polygonaceae	SC	California Desert (K)
Eriogonum kelloggii Gray	Red Mountain buckwheat	Polygonaceae	SC	Ukiah (K)
Eriogonum kennedyi Porter ex Wats. var. pinicola Reveal	Cache Peak buckwheat	Polygonaceae	SC	California Desert (K)
Eriogonum microthecum Nutt. var. panamintense S. Stokes	Panamint Mountains buckwheat	Polygonaceae	SC	California Desert (K)
Eriogonum nudum Dougl. ex Benth. var. murinum Reveal	Mouse buckwheat	Polygonaceae	SC	Bakersfield (S)
Eriogonum ovalifolium Nutt. var. vineum (Small) Nels.	Cushenberry buckwheat	Polygonaceae	SC	California Desert (K)
Eriogonum truncatum T. & G.	Mt. Diablo buckwheat	Polygonaceae	SC	Bakersfield (S)
Eriophyllum mohavense (Jtn.) Jeps.	Barstow wooly-sunflower	Asteraceae	SC	California Desert (K)
Eryngium aristulatum Jeps. var. parishii (Coult. & Rose) Math. & Const.	San Diego button-celery	Apiaceae	SC	California Desert (K)
Eryngium mathiasiae Sheikh	Mathias' coyote-thistle	Apiaceae	SC	Susanville (K)
Eryngium pinnatisectum Jeps.	Tuolumne coyote-thistle	Apiaceae	SC	Bakersfield (S)
Erysimum insulare Greene	Island wallflower	Brassicaceae	SC	Bakersfield (S)
Erysimum menziesii (Hook.) Wettst.	Menzies' wallflower	Brassicaceae	SC	Ukiah (K)
Erythronium tuolumnense Applegate	Tuolumne fawn-lily	Liliaceae	SC	Bakersfield (K)
Eschscholzia procera Greene	Kernville poppy	Papveraceae	SC	Bakersfield (S)
Euphorbia hooveri Wheeler (see Chamaesyce hooveri)				
Euphorbia platysperma (see Chamaesyce platysperma)				
Ferocactus viridescens (T. & G.) Britton & Rose	San Diego barrel cactus	Cactaceae	SC	California Desert (K)
Forsellesia pungens (Bdg.) Heller var. glabra Ensign	Pungent forsellesia	Crossosomataceae	SB 3/	California Desert (K)

Scientific Name	Common Name	Family	Status 1/	District(s) & Occurrence 2/
Fremontodendron decumbens R. Lloyd	Pine Hill flannelbush	Sterculiaceae	SC	Bakersfield (K)
Fremontodendron mexicanum A. Davids.	Mexican fremontia; Mexican flannelbush	Sterculiaceae	SC	California Desert (K)
Fritillaria falcata (Jeps.) D.E. Beetle	Talus fritillary	Liliaceae	SC	Bakersfield (S)
Fritillaria pluriflora Torr.	Adobe-lily	Liliaceae	SC	Ukiah (K)
Fritillaria roderickii Knight (= *F. grayana*)	Roderick's fritillary	Liliaceae	SC	Ukiah (S)
Fritillaria striata Eastw.	Greenhorn adobe-lily	Liliaceae	SC	Bakersfield (S)
Fritillaria viridea Kell.	San Benito fritillary	Liliaceae	SC	Bakersfield (K)
Galium californicum H. & A. ssp. *sierrae* Dempster & Stebbins	El Dorado bedstraw	Rubiaceae	SC	Bakersfield (K)
Gratiola heterosepala Mason & Bacig.	Boggs Lake hedge-hyssop	Scrophulariaceae	SC	Susanville (K)
Helianthella castanea Greene	Diablo rock-rose	Asteraceae	SC	Bakersfield (S)
Helianthus niveus (Benth.) Bdg. ssp. *tephrodes* (Gray) Heiser	Desert sunflower	Asteraceae	SC	California Desert (K)
Hemizonia arida Keck	Red Rock tarweed	Asteraceae	SC	California Desert (K)
Hemizonia conjugens Keck	Otay tarweed	Asteraceae	SC	California Desert (K)
Hemizonia floribunda Gray	Tecate tarweed	Asteraceae	SC	California Desert (K)
Hesperolinon breweri (Gray) Small	Brewer's dwarf flax	Linaceae	SC	Ukiah (S)
Hesperolinon didymocarpum H.K. Sharsm.	Lake County dwarf flax	Linaceae	SC	Ukiah (S)
Hibiscus californicus Kell.	California hibiscus	Malvaceae	SC	Ukiah (S)
Juncus leiospermus F.J. Herm. var. *ahartii* ined.		Juncaceae	SC	Ukiah (S)
Lasthenia burkei (Greene) Greene	Burke's goldfields	Asteraceae	SC	Ukiah (S)
Layia discoidea (Keck) Keck	Rayless tidytips	Asteraceae	SC	Bakersfield (K)
Layia jonesii Gray	Jones' layia	Asteraceae	SC	Bakersfield (K)
Layia leucopappa Keck	Comanche Point layia	Asteraceae	SC	Bakersfield (S)
Lepechinia ganderi Epling	Gander's pitcher-sage	Lamiaceae	SC	California Desert (K)

Scientific Name	Common Name	Family	Status [1]	District(s) & Occurrence [2]
Lewisia stebbinsii Gankin & Hildreth	Stebbins' lewisia	Portulacaceae	SC	Ukiah (S)
Limnanthes bakeri Howell	Baker's meadow foam	Limnanthaceae	SC	Ukiah (S)
Limnanthes floccosa Howell ssp. *bellingeriana* (Peck) Arroyo	Bellinger's meadow foam	Limnanthaceae	SC	Ukiah (S)
Limnanthes floccosa Howell ssp. *californica* Arroyo	Butte County meadow foam	Limnanthaceae	SC	Ukiah (S)
Limnanthes gracilis Howell var. *parishii* (Jeps.) C. Mason	Parish's meadow foam	Limnanthaceae	SC	California Desert (K)
Linanthus maculatus (Parish) Mlkn.	Little San Bernardino Mt. linanthus	Polemoniaceae	SC	California Desert (S)
Lomatium congdonii Coult. & Rose	Congdon's lomatium	Apiaceae	SC	Bakersfield (K)
Lomatium peckianum Math. & Const.	Peck's lomatium	Apiaceae	SC	Ukiah (S)
Lotus crassifolius (Benth.) Greene var. *otayensis* Moran	Otay Mountain lotus	Fabaceae	SB [3]	California Desert (K)
Lupinus excubitus Jones var. *medius* (Jeps.) Munz	Mountain Springs bush lupine	Fabaceae	SC	California Desert (K)
Lupinus magnificus Jones var. *magnificus*	Panamint Mountains lupine	Fabaceae	SC	California Desert (K)
Lupinus ludovicianus Greene	San Luis lupine	Fabaceae	SC	Bakersfield (S)
Lupinus milo-bakeri C.P. Smith	Milo Baker's lupine	Fabaceae	SC	Ukiah (S)
Lupinus padre-crowleyi C.P. Smith		Fabaceae	SC	Bakersfield (S)
Lupinus spectabilis Hoover	Shaggy hair lupine	Fabaceae	SC	Bakersfield (S)
Machaeranthera lagunensis Keck	Laguna Mountains aster	Asteraceae	SC	California Desert (K)
Mahonia nervosa var. *mendocinensis* (see *Berberis nervosa* var. *mendocinensis*)				
Mahonia nevinii (see *Berberis nevinii*)				
Malacothamnus palmeri (Wats.) Greene var. *involucratus* (Rob.) Kearn.	Carmel Valley bush-mallow	Malvaceae	SC	Bakersfield (K)
Malacothrix saxatilis (Nutt.) T. & G. var. *arachnoidea* (McGregor) F. Williams	Carmel Valley malacothrix	Asteraceae	SC	Bakersfield (S)
Marina orcuttii (Wats.) Barneby var. *orcuttii*	California marina	Fabaceae	SC	California Desert (S)

Scientific Name	Common Name	Family	Status 1/	District(s) & Occurrence 2/
Mimulus pygmaeus Grant	Pygmy monkey flower	Scrophulariaceae	SC	Susanville (S)
Mimulus shevockii Heckard & Bacig.	Shevock's monkey flower	Scrophulariaceae	SC	Bakersfield (K)
Minuartia decumbens T.W. Nelson & J.P. Nelson	Lassics sandwort	Caryophyllaceae	SC	Ukiah (S)
Monardella crispa Elmer	Crisp monardella	Lamiaceae	SC	Bakersfield (S)
Monardella robisonii Epling	Robison's monardella	Lamiaceae	SC	California Desert (S)
Nasturtium gambelii O.E. Schulz	Gambel's watercress	Brassicaceae	SC	California Desert (S)
Navarretia pauciflora Mason	Few-flowered navarretia	Polemoniaceae	SC	Ukiah (S)
Navarretia setiloba Cov.	Piute Mountains navarretia	Polemoniaceae	SC	Bakersfield (K)
Nolina interrata Gentry	Dehesa nolina	Agavaceae	SC	California Desert (K)
Opuntia basilaris Engelm. & Bigel. var. *brachyclada* (Griffiths) Munz	Short-joint beaver tail	Cactaceae	SC	California Desert (K)
Opuntia munzii C.B. Wolf	Munz' cholla	Cactaceae	SC	California Desert (K)
Opuntia wigginsii L. Benson	Wiggins' cholla	Cactaceae	SC	California Desert (K)
Orcuttia greenei Vasey (see *Tuctoria greenei*)				
Orcuttia pilosa Hoover	Hairy orcutt grass	Poaceae	SC	Ukiah (S)
Orcuttia tenuis Hitchcock	Slender orcutt grass	Poaceae	SC	Ukiah (K); Susanville (K)
Orthocarpus pachystachyus Gray	Shasta owl's-clover	Scrophulariaceae	SC	Ukiah (S)
Oryctes nevadensis Wats.	Nevada oryctes	Solanaceae	SC	Bakersfield (K)
Parvisedum leiocarpum (H.K. Sharsm.) Clausen	Lake County stonecrop	Crassulaceae	SC	Ukiah (S)
Penstemon personatus Keck	Closed-throated beardtongue	Scrophulariaceae	SC	Ukiah (K); Susanville (S)
Penstemon stephensii Bdg.	Stephen's beardtongue	Scrophulariaceae	SC	California Desert (K)
Pentachaeta exilis (Gray) Gray ssp. *aeolica* Van Horn & Ornduff	Slender pentachaeta	Asteraceae	SC	Bakersfield (K)
Perideridia gairdneri (H. & A.) Math. ssp. *gairdneri*	Gairdner's yampah	Apiaceae	SC	Ukiah (S)
Perityle inyoensis (Ferris) Powell	Inyo laphamia	Asteraceae	SC	Bakersfield (S); California Desert (K)

Scientific Name	Common Name	Family	Status [1]	District(s) & Occurrence [2]
Petalonyx thurberi Gray ssp. gilmanii (Munz) Davis & Thompson	Death Valley sandpaper plant	Loasaceae	SC	California Desert (K)
Phacelia amabilis Const.	Saline Valley phacelia	Hydrophyllaceae	SC	California Desert (K)
Phacelia cookei Const. & Heckard	Cooke's phacelia	Hydrophyllaceae	SC	Susanville (S); Ukiah (S)
Phacelia dalesiana J.T. Howell	Scott Mountain phacelia	Hydrophyllaceae	SC	Ukiah (S)
Phacelia greenei J.T. Howell	Scott Valley phacelia	Hydrophyllaceae	SC	Ukiah (S)
Phacelia monoensis Halse	Mono County phacelia	Hydrophyllaceae	SC	California Desert (S); Bakersfield (K)
Phacelia nashiana Jeps.	Nash's phacelia	Hydrophyllaceae	SB [3]	Bakersfield (K); California Desert (K)
Phacelia novenmillensis Munz	Nine Mile Canyon phacelia	Hydrophyllaceae	SC	Bakersfield (K); California Desert (S)
Phacelia phacelioides (Benth.) Brand	Mount Diablo phacelia	Hydrophyllaceae	SC	Bakersfield (S)
Phlox hirsuta E. Nels.	Yreka phlox	Polemoniaceae	SC	Ukiah (S)
Plagiobothrys glyptocarpus (Piper) Jtn. var. modestus Jtn.	Cedar Crest allocarya	Boraginaceae	SC	Bakersfield (S)
Pleuropogon hooverianus (L. Benson) J.T. Howell	Hoover's semaphore grass	Poaceae	SC	Ukiah (S)
Poa fibrata Swallen	Lassen County bluegrass	Poaceae	SC	Susanville (S)
Pogogyne nudiuscula Gray	Otay pogogyne	Lamiaceae	SC	California Desert (K)
Potentilla patellifera J.T. Howell	Kingston Mountains cinquefoil	Rosaceae	SC	California Desert (K)
Pseudobahia bahiaefolia (Benth.) Rydb.	Hartweg's pseudobahia	Asteraceae	SC	Bakersfield (S)
Pseudobahia peirsonii Munz	Tulare pseudobahia	Asteraceae	SC	Bakersfield (K)
Puccinellia parishii Hitchc.	Parish's alkali grass	Poaceae	SC	California Desert (K)
Ribes canthariforme Wiggins	Moreno currant	Saxifragaceae	SC	California Desert (K)
Rorippa columbiae Suskd. ex J.T. Howell	Columbia yellow cress	Brassicaceae	SC	Susanville (S)
Salvia greatae Bdg.	Orocopia sage	Lamiaceae	SC	California Desert (K)
Sanicula saxatilis Greene	Rock sanicle	Apiaceae	SC	Bakersfield (S)

Scientific Name	Common Name	Family	Status 1/	District(s) & Occurrence 2/
Sanicula tracyi Shan & Const.	Tracy's sanicle	Apiaceae	SC	Ukiah (S)
Scutellaria holmgreniorum Cronq.	Ravendale skull-cap	Lamiaceae	SC	Susanville (K)
Sedum albomarginatum Clausen	Feather River stonecrop	Crassulaceae	SC	Ukiah (S); Susanville (S)
Sedum laxum (Britton) Berger ssp. eastwoodiae (Britton) Clausen	Red Mountain stonecrop	Crassulaceae	SC	Ukiah (K)
Sedum obtusatum Gray ssp. paradisum Denton	Canyon Creek stonecrop	Crassulaceae	SC	Ukiah (K)
Senecio ganderi Barkley & Beauchamp	Gander's butterweed	Asteraceae	SC	California Desert (K)
Sidalcea covillei Greene	Owens Valley checker-mallow	Malvaceae	SC	Bakersfield (K)
Sidalcea hickmanii Greene ssp. anomala C.L. Hitchcock	Cuesta Pass checker-mallow	Malvaceae	SC	Bakersfield (S)
Sidalcea hickmanii Greene ssp. hickmanii	Hickman's checker-mallow	Malvaceae	SC	Bakersfield (S)
Sidalcea robusta Heller ex Roush	Butte County checker-mallow	Malvaceae	SC	Ukiah (K)
Silene campanulata Wats. ssp. campanulata	Red Mountain campion	Caryophyllaceae	SC	Ukiah (K)
Solanum tenuilobatum Parish	Narrow-leaved nightshade	Solanaceae	SC	California Desert (K)
Sphaeralcea rusbyi Gray var. eremicola (Jeps.) Keam.	Rusby's desert-mallow	Malvaceae	SC	California Desert (K)
Streptanthus albidus Greene ssp. albidus	Metcalf Canyon jewel-flower	Brassicaceae	SC	Bakersfield (S)
Streptanthus brachiatus F.W. Hoffmann	Socrates Mine jewel-flower	Brassicaceae	SC	Ukiah (K)
Streptanthus callistus Morrison	Mount Hamilton jewel-flower	Brassicaceae	SC	Bakersfield (S)
Streptanthus cordatus Nutt. var. piutensis J.T. Howell	Piute Mountains jewel-flower	Brassicaceae	SC	Bakersfield (K)
Streptanthus glandulosus Hook. var. hoffmannii Kruckeberg	Hoffmann's jewel-flower	Brassicaceae	SC	Ukiah (S)
Streptanthus morrisonii F.W. Hoffmann	Morrison's jewel-flower	Brassicaceae	SC	Ukiah (K)
Traycina rostrata Blake	Beaked traycina	Asteraceae	SC	Ukiah (S)
Tuctoria greenei (Vasey) J. Reeder	Greene's orcutt grass	Poaceae	SC	Bakersfield (S); Ukiah (S)

Scientific Name	Common Name	Family	Status 1/	District(s) & Occurrence 2/
Verbena californica Moldenke	Red Hills vervain	Verbenaceae	SC	Bakersfield (K)
Wyethia reticulata Greene	El Dorado mule ears	Asteraceae	SC	Bakersfield (K)
Xylorhiza orcuttii (Vasey & Rose) Greene	Orcutt's woody aster	Asteraceae	SC	California Desert (K)

1/ Status: SC = sensitive candidate (taxon has been identified as a candidate for listing as endangered or threatened by the Fish and Wildlife Service in a *Federal Register* Notice of Review); SP = sensitive proposed (taxon has been officially proposed for listing as endangered or threatened by the Fish and Wildlife Service in a *Federal Register* Notice); SB = sensitive Bureau (taxon is neither a candidate nor a proposed species, but has been designated as sensitive by the California State Director).

2/ Occurrence: K = known to occur on public lands; S = suspected to occur on public lands.

3/ These are being designated Bureau sensitive species because the Fish and Wildlife Service's Sacramento Endangered Species Office proposes to add them to the FWS candidate species list.

APPENDIX K

TOXICITY RESEARCH COSTS

Council on Environmental Quality regulations (40 CFR 1502.22) require that gaps in relevant information or scientific uncertainty be included in an EIS unless the cost of obtaining such information is exorbitant. It would be virtually impossible for BLM with its limited resources to conduct the research on toxicity of herbicides needed to answer the questions that have arisen either from data gaps or scientific discord. Neither 2,4-D nor picloram has been shown to be a potent carcinogen. To identify a sample population large enough to differentiate between cancer induced by exposure to these herbicides and cancer caused by exposure to other environmental factors such as diet, polluted air, drinking water, or predisposition by other natural factors, would be a prohibitively time-consuming (3-5 years) and costly process. The cost exorbitance of such research is shown in Table K-1. In response to existing data gaps on 2,4-D and picloram, registrants are conducting research. On the basis of the cost of filling the research gaps identified for the program level, the cost of filling the data gaps has been determined to be exorbitant unless a worst-case analysis finds a substantive risk of cancer.

Table K-1. Estimated Costs of Research to Fill Data Gaps or to Resolve Scientific Uncertainties Pertaining to 2,4-D, Picloram, and Glyphosate

Test	Cost Estimate ($)[1] 1984	2,4-D	Picloram	Glyphosate
Acute Toxicity (including dermal, inhalation and oral in guinea pigs and dogs)	110,000	●	●	
Subchronic Toxicity (including dermal, inhalation, and oral in rats, dogs, and rabbits)	525,254		●	●
Chronic Toxicity (three-phase tests in rats and dogs)	1,685,165	●	●	●
Oncogenicity (three-phase tests in rats and mice)	1,576,186	●	●	●
Teratogenicity (three-phase tests in rats and rabbits)	129,760	●	●	
Mutagenicity (including Ames test, mutation assays, sex-linked lethal assays, somatic cell mutations, and locus gene mutations)	36,131		●	
Chromosomal Effects (including cytogenetics, heritable translocations, and unscheduled DNA synthesis)	110,000		●	●
Total	4,172,496	3,501,111	4,172,496	3,896,605

[1] Based on Centaur Associates estimates from 1980 to 1982 and updated using the Consumer Price Index.

APPENDIX L

WILDLIFE AND AQUATIC ORGANISM RISK ASSESSMENT

A risk assessment was conducted to determine the potential wildlife and aquatic impacts of the use of 16 herbicides used in BLM's vegetation management program. The risk assessment determined that in general risks to wildlife from BLM's vegetation management program are low. A general description of the wildlife risk assessment is given here.

Toxic effects to wildlife and aquatic organisms from vegetation management with herbicides is a function of the inherent toxicity (hazard) of each of the herbicides to different animals and of the amount of each chemical (exposure) wildlife may take in during a control operation. In essence the wildlife risk assessment compared estimated acute exposures of different animals with acute toxicity levels found in lab animals. Details of the wildlife hazard analysis and exposure analysis are given at the end of this section.

WILDLIFE HAZARD ANALYSIS

The toxicity of herbicides to wildlife varies among individuals of the same species (intraspecific), between different species (interspecific), and, often most markedly, between different classes of animals. Thus, a chemical may be more toxic to birds than to mammals, or more toxic to fish than to birds. However, toxicity testing has been conducted on relatively few wildlife species. Most laboratory testing has been done on rats and mice to estimate human toxicity. Thus, to determine the potential impacts of estimated doses on wildlife, it is necessary to compare those estimates with laboratory results on the few species that have been tested. Wildlife toxicity reference levels used to assess the risks of the 16 herbicides are given in Tables L-1 to L-16 in the discussion of wildlife risks.

WILDLIFE EXPOSURE ANALYSIS

An analysis of the 16 herbicides' risk to wildlife compared estimated acute doses for representative wildlife species with available hazard information on closely related species. Because the herbicides examined in this EIS show no tendency to bioaccumulate, long-term persistence in food chains and subsequent toxic effects, such as those that result from the use of persistent organochlorides were not considered a problem and were not examined in the risk analysis. Because the herbicides degrade relatively rapidly and sites are normally treated only once in a given year, no analysis of chronic wildlife dosing was done. Avian toxicity data were used as surrogates for assessing risks to terrestrial amphibians and reptiles because laboratory studies on those animal classes are not available.

Doses were estimated for a set of representative species that normally inhabit vegetation management areas and that, because of their relatively high population levels and broad habitat requirements, are most likely to be exposed. A number of domestic animal species were also included. The species were as follows:

Birds	Mammals	Amphibian	Reptile	Domestic Animals
Flicker	Mouse	Toad	Snake	Cow
Mourning Dove	Rabbit			Chicken
Jay	Deer			Dog
Kingfisher	Fox			
Screech Owl				

Herbicide doses for these representative species were calculated using a series of conservative, simplifying assumptions concerning routine spraying operations giving highly unlikely dose estimates.

Highly unlikely dermal exposures were based on the levels likely to be found on vegetation leaf surfaces because the animals are assumed to seek cover during a spraying operation. A dermal penetration rate of 10 percent was used for all 16 herbicides to determine what portion of their dermal exposure actually penetrated their skin. In highly unlikely exposures, mammals and birds are assumed to receive an additional indirect dermal dose from grooming their fur or preening their feathers.

Highly unlikely ingestion doses were assumed to come from animals eating a specified percentage of their daily food intake in contaminated items. The percentage depends on their body size.

Inhalation exposures were assumed to come from a hypothetical amount of herbicide droplets forming a cloud that moves slowly offsite. Animals are exposed for ten minutes. As noted in the exposure details at the end of this section, inhalation exposure constitutes a negligible fraction of any animal's total herbicide dose.

The total systemic dose to each animal was calculated as the sum of the estimated doses received via dermal, ingestion, and inhalation routes. Tables L-1 to L-16 give the total highly unlikely dose estimates for the representative species.

WILDLIFE RISK ANALYSIS

For wildlife risks, the criteria used by EPA in ecological risk assessment (EPA, 1986) are used here to judge the absolute risks to organisms and the relative risks among the 16 herbicides. The EPA criteria call for comparison of an estimated environmental concentration (EEC) with a laboratory-determined LD_{50} or LC_{50} for the most closely related laboratory test species.

Where the EEC exceeds one-fifth (1/5) the LD_{50} or LC_{50}, EPA deems it a significant risk that may be mitigated by restricting the use of the pesticide. EPA judges EECs that exceed the LD_{50} or LC_{50} as unacceptable risk levels. In this risk assessment, an organism's total estimated dose (rather than an EEC) is compared with the laboratory toxicity level because the dose comes from all exposure routes, not just feeding.

The wildlife risk assessment tends to overstate the risks because many of the assumptions are quite conservative. For example, no degradation of the herbicides is assumed to occur; all herbicide sprayed is assumed to be biologically available. In the highly unlikely case a significant percentage (7 to 55 percent depending on body size) of the diet is assumed to be contaminated. Birds and mammals are assumed to receive dermal doses through their skin and from grooming. Dermal exposures are assumed to come both directly from herbicide spray and indirectly from brushing up against treated vegetation. This accumulation of doses from every conceivable route undoubtedly overestimates doses. Nevertheless, when these dose estimates do exceed the EPA risk criterion, and more so when they exceed the LD_{50} for the most closely related laboratory species, there is a clear risk of adverse effects on individual animals.

WILDLIFE RISK OVERVIEW

In general, risks to wildlife from the use of herbicides are low to negligible in BLM's vegetation management program. Most highly unlikely dose estimates are well below the EPA risk criterion of 1/5 LD_{50} and are far below the lab species LD_{50}. 2,4-D and triclopyr present the highest risks to wildlife. Dalapon, fosamine, glyphosate, and simazine present the lowest risks.

Local populations of small mammals, small birds, terrestrial amphibians, and reptiles may be adversely affected if large areas are treated, however, the reproductive capacity of these species is generally high enough to replace the few lost individuals within the next breeding cycle. Populations of larger mammals and birds and any domestic animals present are not likely to be affected at all. Areas with sensitive species will be avoided.

WILDLIFE RISK ANALYSIS

The risk to wildlife from the use of amitrole is low. The estimated realistic amitrole doses to wildlife (Table L-1) are less than one-tenth of the EPA 1/5 LD_{50} risk level except for the toad for which the realistic dose is one-eighth of the EPA 1/5 LD_{50} level. The worst case doses slightly exceed the EPA criterion for the flicker, toad, and snake so that there is some risk to birds, terrestrial amphibians, and reptiles. No amitrole wildlife dose approaches the LD_{50}.

Asulam wildlife risks are very low. Even in the highly unlikely applications, no wildlife doses exceed the EPA 1/5 LD_{50} risk levels (Table L-2). The most sensitive species, mice, is only one-tenth of the EPA 1/5 LD_{50}. The highly unlikely doses for the remaining species are far below the EPA levels so wildlife should not be directly affected by the use of asulam.

There is a greater risk of wildlife effects from the use of atrazine. In many species the highly unlikely dose is one-fifth to one-half of the EPA 1/5 LD_{50} risk level (Table L-3) although no highly unlikely dose exceeds it. Reptiles and amphibians have the most risk but larger mammals should not be affected by atrazine.

Wildlife risk from the use of bromacil is difficult to judge because so little bromacil toxicity data exist (Table L-4). Routine doses do not appear to pose a significant risk. It appears that birds, terrestrial amphibians, and reptiles may be at some risk from worst-case doses although this conclusion is based on decreased weight gain in chickens. Small mammals such as mice may also be at risk in worst-case applications of bromacil but larger mammals should not be adversely affected.

Risks to wildlife from the use of 2,4-D are low to moderate for highly unlikely exposures. Risks to reptiles and amphibians may be moderately high--the highly unlikely dose for toads exceeds the EPA 1/5 LD_{50} risk level (Table L-5). The risk to small mammals is also above 1/5 LD_{50} dose. All species are well below the LD_{50}.

Birds, small mammals, terrestrial amphibians, and reptiles may be at a moderate level of risk from the use of 2,4-DP. Their realistic dose levels (Table L-6) represent a significant portion of the EPA 1/5 LD_{50} risk level. Their worst-case estimated doses exceed the EPA levels and a number exceed the LD_{50} (flicker, jay, toad, snake). However, it must be noted that the LD_{50}s for these species are based on lethal levels for 2,4-D in the chukar since data on 2,4-DP are lacking. It does not appear that larger mammals are at risk from 2,4-DP use.

Dalapon wildlife risk is relatively low. The highly unlikely dose for the mouse (Table L-7) is only 17 percent of the EPA 1/5 LD_{50} risk level. All other dalapon doses are well below the EPA risk level.

Dicamba presents very little risk to wildlife. No species approach the EPA 1/5 LD_{50} dose (Table L-8).

Diuron highly unlikely wildlife doses (Table L-9) are well below the EPA 1/5 LD_{50} risk level, so the risk to wildlife from diuron use will be insignificant.

Fosamine presents a negligible risk of wildlife effects under highly unlikely spraying conditions. The highly unlikely doses (Table L-10) are well below the EPA 1/5 LD_{50} risk levels.

Available data indicate that glyphosate poses very little risk to wildlife even under highly unlikely spraying conditions. Toxicity data on avian species (Table L-11) are not sufficient to accurately judge potential glyphosate effects on birds but the risk from glyphosate use appears to be relatively low even in highly unlikely applications.

Hexazinone presents a low risk to wildlife. The highly unlikely dose to the mouse is one-fifth the EPA 1/5 LD_{50} risk level (Table L-12). The highly unlikely doses to birds, amphibians, and reptiles represent insignificant portions of the EPA risk level. Hexazinone risk to larger mammals appears to be very low.

Picloram wildlife risk is low based on highly unlikely doses (Table L-13) that are well below the EPA 1/5 LD_{50} risk level. The same is true of simazine (Table L-14) and tebuthiuron (Table L-15).

Risk to wildlife from the use of triclopyr is much higher. The small mammal (mouse) highly unlikely dose (Table L-16) is 80 percent of the EPA 1/5 LD_{50} so far. Amphibians appear to be at moderate risk in the highly unlikely case. Larger mammals are a low to negligible risk from triclopyr use.

Table L-1
Amitrole Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	34	400	2000	Mallard
Mourning Dove	22	400	2000	Mallard
Jay	29	400	2000	Mallard
Kingfisher	6.6	400	2000	Mallard
Screech Owl	22	400	2000	Mallard
Mouse	78	2940	14,700	Mouse
Rabbit	9.6	2000	10,000	Rabbit
Deer	1.6	2000	10,000	Rabbit
Fox	4.0	350	1750	Cat
Toad	48	400	2000	Mallard
Snake	35	400	2000	Mallard
Cow	0.8	2000	10,000	Rabbit
Chicken	13	400	2000	Mallard
Dog	0.4	350	1750	Cat

Table L-2
Asulam Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	41	520	2600	Partridge
Mourning Dove	27	800	4000	Pigeon
Jay	35	520	2600	Partridge
Kingfisher	8.0	520	2600	Partridge
Screech Owl	27	520	2600	Partridge
Mouse	94	800	4000	Rat
Rabbit	11	800	4000	Rabbit
Deer	1.9	800	4000	Rabbit
Fox	4.8	800	4000	Rat
Toad	58	520	2600	Partridge
Snake	42	520	2600	Partridge
Cow	0.9	800	4000	Rabbit
Chicken	15	520	2600	Partridge
Dog	0.5	800	4000	Rat

Table L-3
Atrazine Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	64	188	940	Bobwhite
Mourning Dove	42	188	940	Bobwhite
Jay	55	188	940	Bobwhite
Kingfisher	12	188	940	Bobwhite
Screech Owl	42	188	940	Bobwhite
Mouse	147	798	3992	Mouse
Rabbit	18	374	1869	Rat
Deer	3.0	374	1869	Rat
Fox	7.5	374	1869	Rat
Toad	91	188	940	Bobwhite
Snake	69	188	940	Bobwhite
Cow	1.5	374	1869	Rat
Chicken	24	188	940	Bobwhite
Dog	0.8	374	1869	Rat

Table L-4
Bromacil Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	68	250[a]	na	Chicken
Mourning Dove	44	250	na	Chicken
Jay	59	250	na	Chicken
Kingfisher	13	250	na	Chicken
Screech Owl	45	250	na	Chicken
Mouse	157	800	3998	Rat
Rabbit	19	800	3998	Rat
Deer	3.2	800	3998	Rat
Fox	8.0	800	3998	Rat
Toad	97	250	na	Chicken
Snake	69	250	na	Chicken
Cow	1.6	800	3998	Rat
Chicken	25	250	na	Chicken
Dog	0.8	800	3998	Rat

na = not available.

[a] All 1/5 LD_{50} values are based on reduced weight gain, not based on LD_{50}.

Table L-5
2,4-D Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	43	94	472	Pheasant
Morning Dove	28	94	472	Pheasant
Jay	37	94	472	Pheasant
Kingfisher	8.3	94	472	Pheasant
Screech Owl	28	94	472	Pheasant
Mouse	98	76	380	Mouse
Rabbit	12	84	424	Rabbit
Deer	2.0	80	400	Deer
Fox	5.0	20	100	Dog
Toad	61	40	200	Toad
Snake	43	40	200	Toad
Cow	1.0	10	50	Cow
Chicken	16	76	380	Chicken
Dog	0.5	20	100	Dog

Table L-6
2,4-DP Wildlife and Domestic Animal Doses (mg/kg)
Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	34	40[a]	200	Chukar
Morning Dove	22	40	200	Chukar
Jay	29	40	200	Chukar
Kingfisher	6.6	40	200	Chukar
Screech Owl	22	40	200	Chukar
Mouse	78	130	650	Mouse
Rabbit	6.6	106	532	Rat
Deer	1.6	106	532	Rat
Fox	4.0	106	532	Rat
Toad	48	40	200	Chukar
Snake	35	40	200	Chukar
Cow	0.8	106	532	Rat
Chicken	13	40	200	Chukar
Dog	0.4	106	532	Rat

[a] Based on lowest LD_{50} for avian species for 2,4-D. No avian LD_{50} available for 2,4-DP.

Table L-7
Dalapon Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	68	1132	5660	Chicken
Mourning Dove	44	1132	5660	Chicken
Jay	59	1132	5660	Chicken
Kingfisher	13	1132	5660	Chicken
Screech Owl	45	1132	5660	Chicken
Mouse	157	920	4600	Mouse
Rabbit	19	772	3860	Rabbit
Deer	3.2	772	3860	Guinea Pig
Fox	8.0	772	3860	Guinea Pig
Toad	97	1132	5660	Chicken
Snake	69	1132	5660	Chicken
Cow	1.6	772	3860	Guinea Pig
Chicken	25	1132	5660	Chicken
Dog	0.8	772	3860	Guinea Pig

Table L-8
Dicamba Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	17	135	673	Pheasant
Morning Dove	11	135	673	Pheasant
Jay	15	135	673	Pheasant
Kingfisher	3.3	135	673	Pheasant
Screech Owl	11	135	673	Pheasant
Mouse	39	238	1189	Mouse
Rabbit	4.8	400	2000	Rabbit
Deer	0.8	151	757	Rat
Fox	2.0	151	757	Rat
Toad	24	135	673	Pheasant
Snake	17	135	673	Pheasant
Cow	0.4	151	757	Rat
Chicken	6.3	135	673	Pheasant
Dog	0.2	151	757	Rat

Table L-9
Diuron Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	68	400	2000	Mallard
Mourning Dove	44	400	2000	Mallard
Jay	59	400	2000	Mallard
Kingfisher	13	400	2000	Mallard
Screech Owl	45	400	2000	Mallard
Mouse	157	750	3750	Rat
Rabbit	19	750	3750	Rat
Deer	3	750	3750	Rat
Fox	8	750	3750	Rat
Toad	97	400	2000	Mallard
Snake	69	400	2000	Mallard
Cow	1.6	750	3750	Rat
Chicken	25	10	na	Chicken
Dog	0.8	750	3750	Rat

n.a. = not available

[a] Based on decreased weight loss in chickens

Table L-10
Fosamine Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	51	1000	5000	Bobwhite
Mourning Dove	33	1000	5000	Bobwhite
Jay	44	1000	5000	Bobwhite
Kingfisher	10	1000	5000	Bobwhite
Screech Owl	34	1000	5000	bobwhite
Mouse	118	4880	24400	Rat
Rabbit	14	1476	7380	Guinea Pig
Deer	2.4	1476	7380	Guinea Pig
Fox	6	3000	15000	Dog
Toad	73	1000	5000	Bobwhite
Snake	52	1000	5000	Bobwhite
Cow	1.2	1476	7380	Guinea Pig
Chicken	19	1000	5000	Bobwhite
Dog	0.6	3000	15,000	Dog

Table L-11
Glyphosate Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	34	928	4640	Quail
Morning Dove	22	928	4640	Quail
Jay	29	928	4640	Quail
Kingfisher	6.6	928	4640	Quail
Screech Owl	22	928	4640	Quail
Mouse	78	800	4000	Rat
Rabbit	9.6	760	3800	Rabbit
Deer	1.6	760	3800	Rabbit
Fox	4	760	3800	Rabbit
Toad	48	928	4640	Quail
Snake	35	928	4640	Quail
Cow	0.8	760	3800	Rabbit
Chicken	13	928	4640	Quail
Dog	0.4	760	3800	Rabbit

Table L-12
Hexazinone Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	43	452	2258	Bobwhite
Mourning Dove	28	452	2258	Bobwhite
Jay	37	452	2258	Bobwhite
Kingfisher	8.3	452	2258	Bobwhite
Screech Owl	28	452	2258	Bobwhite
Mouse	98	338	1690	Rat
Rabbit	12	172	860	Guinea Pig
Deer	2.0	172	860	Guinea Pig
Fox	5.0	172	860	Guinea Pig
Toad	61	452	2258	Bobwhite
Snake	43	452	2258	Bobwhite
Cow	1.0	172	860	Guinea Pig
Chicken	16	452	2258	Bobwhite
Dog	0.5	172	860	Guinea Pig

Table L-13
Picloram Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	17	400	2000	Pheasant
Morning Dove	11	400	2000	Pheasant
Jay	15	400	2000	Pheasant
Kingfisher	3.3	400	2000	Pheasant
Screech Owl	11	400	2000	Pheasant
Mouse	39	400	2000	Mouse
Rabbit	4.8	400	2000	Rabbit
Deer	0.8	200	1000	Sheep
Fox	2.0	400	2000	Mouse
Toad	24	400	2000	Pheasant
Snake	17	400	2000	Pheasant
Cow	0.4	200	1000	Sheep
Chicken	6.3	400	2000	Pheasant
Dog	0.2	400	2000	Mouse

Table L-14
Simazine Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	68	928	4640	Mallard
Mourning Dove	44	928	4640	Mallard
Jay	59	928	4640	Mallard
Kingfisher	13	928	4640	Mallard
Screech Owl	45	928	4640	Mallard
Mouse	157	1000	5000	Mouse
Rabbit	19	1000	5000	Rat
Deer	3.2	250[a]	na	Sheep
Fox	8.0	1000	5000	Rat
Toad	97	928	4640	Mallard
Snake	69	928	4640	Mallard
Cow	1.6	250[a]	na	Cattle
Chicken	25	928	4640	Mallard
Dog	0.8	1000	5000	Rat

na = not available

[a] Based on intoxication and weight loss in sheep and cattle.

Table L-15
Tebuthiuron Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	17	400	2000	Bobwhite
Mourning Dove	11	400	2000	Bobwhite
Jay	15	400	2000	Bobwhite
Kingfisher	3.3	400	2000	Bobwhite
Screech Owl	11	400	2000	Bobwhite
Mouse	39	116	579	Mouse
Rabbit	4.8	57	286	Rabbit
Deer	0.8	57	286	Rabbit
Fox	2.0	100	500	Dog
Toad	24	400	2000	Bobwhite
Snake	17	400	2000	Bobwhite
Cow	0.4	57	286	Rabbit
Chicken	6.3	100	500	Chicken
Dog	0.2	100	500	Dog

Table L-16
Triclopyr Wildlife and Domestic Animal Doses (mg/kg) Compared With Lab Acute Toxicity

Species	Highly Unlikely Dose Estimate	1/5 LD_{50}	LD_{50}	Laboratory Species
Flicker	34	340	1698	Mallard
Mourning Dove	22	340	1698	Mallard
Jay	29	340	1698	Mallard
Kingfisher	6.6	340	1698	Mallard
Screech Owl	22	340	1698	Mallard
Mouse	78	94	471	Mouse
Rabbit	9.6	110	550	Rabbit
Deer	1.6	62	310	Guinea Pig
Fox	4.0	62	310	Guinea Pig
Toad	48	340	1698	Mallard
Snake	35	340	1698	Mallard
Cow	0.8	62	310	Guinea Pig
Chicken	13	340	1698	Mallard
Dog	0.4	62	310	Guinea Pig

Details of the Wildlife Exposure Calculations

Wildlife exposures were calculated for a series of representative wildlife species typical of areas supporting forest vegetation in the Northwest and represent a range of phylogenetic classes, body sizes, and feeding niches. Table L-18 lists the representative wildlife species with various biological parameters used in the exposure analysis. References used in the species selection and in deriving the physical parameters of each species were Schmidt and Gilbert (1978), Scott et al. (1977), Burt and Grossenheider (1966), and Robbins et al. (1983).

Highly unlikely exposure estimates were made for each representative species for each of the three major exposure routes: inhalation, dermal, and ingestion. Exposures were based on the herbicide application rates for the highly unlikely. These rates are listed in Table L-17.

Table L-17
Application Rates Used for Highly Unlikely Case Scenarios
(lb/active ingredient/acre)

	Aerial Highly Unlikely	Backpack Highly Unlikely	Right-of-Way Highly Unlikely
Amitrole	---	2.00	2.00
Asulam	---	1.20	2.40
Atrazine	3.75	3.00	3.00
Bromacil	---	4.00	4.00
2,4-D	2.50	2.00	2.50
2,4-DP	---	2.00	2.50
Dalapon	---	4.00	4.00
Dicamba	---	0.50	1.00
Diuron	---	4.00	4.00
Fosamine	---	3.00	4.00
Glyphosate	---	1.50	2.00
Hexazinone	2.50	1.12	2.50
Picloram	1.00	1.00	1.00
Simazine	---	2.00	2.00
Tebuthiuron	---	1.50	2.20
Triclopyr	2.00	2.00	2.00

--- = Not proposed for aerial use.

Inhalation Exposures. Wildlife inhalation exposures were based on air sampling data from pesticide field applications, adjusted to give a dose at a breathing rate of 1 L/min for an exposure of 10 minutes. The dose was weighted by each animal's breathing rate based on the following equations:

Birds:

$$\mathrm{LPM} = \frac{284 \times (\mathrm{BWT}/1000)^{.77}}{1000}$$

Mammals:

$$\mathrm{LPM} = \frac{379 \times (\mathrm{BWT}/1000)^{.80}}{1000}$$

Reptiles:

LPM = .00334

Amphibians:

LPM = .007

where:

LPM is the animal's breathing rate in liters per minute

BWT is the animal's body weight in grams

The equations for birds and mammals were taken from Lasiewski and Calder (1971). The reptile value is from Gordon et al. (1968), who report a study on the collared lizard. The breathing rate for amphibians was from Hutchinson et al. (1968). As anticipated, the animal modeling results showed inhalation exposures to be only a small fraction of each species' total dose.

Dermal Exposures. Dermal exposures were assumed to come from two sources: (1) directly from herbicide spray at the deposition rate that should occur on vegetation leaf surfaces in the highly unlikely case, and (2) indirectly by contact with contaminated vegetation. Fur, feathers, and scales afford varying degrees of protection against dermal exposure; by preventing the chemical from reaching the animal's skin, they may instead allow the chemical to dry or to be rubbed off in their movements. For this reason, the dermal penetration value of 10 percent for mammals was adjusted for the three other classes. The dermal penetration factors that were multiplied by the mammalian penetration rate were as follows: (1) birds, 0.75; (2) reptiles, 0.15; and (3) amphibians, 5.0. The amphibian factor is high because the moist, glandular skin of the amphibian serves to a large extent as a respiratory organ and is many times more permeable than the other animal classes.

Wildlife may receive indirect dermal exposure in moving through contaminated vegetation by transferring pesticide from the vegetation to their body surface. The transfer would depend on (1) the density of the vegetation, (2) the animal's body size in relation to the height of the vegetation, and (3) the amount of movement of the animal.

To simplify the analysis, it was assumed that a certain percentage of the animal's total body surface received herbicide at the same level as in direct dermal exposure (the level on leaf surfaces in the highly unlikely case). That percentage was based on the animal's body size and a movement factor (MVF) to adjust for the taxonomic class. (Mammals, for example, are expected to move more than amphibians.) The animal's total body surface area was assumed to be a function of its weight according to the following formula (Kendeigh, 1970; Schmidt-Nielsen, 1972):

$$BSA = 10 \times (BWT)^{.667}$$

where:

BSA is the animal's body surface area in cm^2

BWT is the animal's body weight in grams

The animal's vegetation contact percent (VCP) is based on its body weight in grams (BWT) according to the following formula:

$$VCP = 2.89\ (BWT)^{-.3775}$$

The class adjustment factors (MVFs) for differing movement are as follows: (1) birds, 0.8; (2) mammals, 1; (3) reptiles, 0.3; and (4) amphibians, 0.4. The indirect dermal dose (IND) is then calculated using the direct dermal dose (DDD):

$$IND = DDD + (DDD \times VCP \times MVF)$$

Mammals and birds groom themselves regularly and may receive an ingestion dose if their fur or feathers are contaminated. The percent of their body surface groomed (PBG) was assumed to be a decreasing function of their body size according to the following formula:

$$PBG = 1.72\ (BWT)^{-.29}$$

No grooming was assumed for reptiles and amphibians. The oral dose for mammals and birds from grooming was subtracted from the amount of herbicide that would contribute to the animal's dermal dose.

Ingestion Doses. Each representative species was assumed to feed on contaminated food items according to a specified diet and to drink a specified amount of water. These dietary amounts are listed in Table L-19. The diet items--seeds, insects, and berries--are assumed to have the following weights, surface areas, and contamination level based on a 1 lb/acre application rate:

	Weight (g)	Surface Area (cm^2)	contamination level in ppm based on a 1 lb/acre application
seeds	.002	.158	885
insects	.00322	.22	766
berries	.5	3.1416	70

These items are assumed to be contaminated over their entire surface area at the level on vegetation leaf surfaces in highly unlikely cases. Grass was assumed to be contaminated at the level of 178.9 mg/kg per pound of herbicide applied per acre on site. Water is assumed to be drunk from a stream 6 inches deep 100 feet offsite that reaches a concentration of 7.5 ppb per pound of herbicide applied per acre. Predators that feed on mice or toads are assumed to receive the total body burden each of these prey species has received through the three exposure routes described above as a result of the herbicide spraying operation. Predators that feed on fish are assumed to receive residue levels based on the concentration in the water. In the highly unlikely exposures each species is assumed to consume a percentage of its daily intake in contaminated food items depending on its body size. The percentages are listed in Table L-18 and are based on the formula:

$$\% = 100 \times (1/(BWT)^{.2})$$

Table L-18 Representative Wildlife and Domestic Species and Associated Biological Parameters

Representative Niche	Representative Species	Body Weight (Grams)	Daily Food Intake (Grams)	Percent of Food Contaminated in Highly Unlikely Case	Body Surface Area (cm^2)	Body Surface Contacting Vegetation (Percent)	Percent of Body Groomed	Inhalation Volume (L/min)
Insectivorous Birds	Flicker	75	15	42	178	57	49	.038
Granivorous Birds	Dove	100	11	40	216	51	45	.048
Omnivorous Birds	Jay	70	14	43	170	58	50	.037
Piscivorous Birds	Kingfisher	250	50	33	398	36	35	.098
Carnivorous Birds	Owl	100	20	40	216	51	45	.048
Small Omnivorous Mammals	Mouse	20	6	55	74	93	72	.017
Medium Herbivorous Mammals	Rabbit	1,350	130	24	1,224	19	21	.480
Large Herbivorous Mammals	Deer	68,000	2,500	11	16,722	4	7	11.1
Carnivorous Mammals	Fox	5,670	475	18	3,189	11	14	1.52
Insectivorous Amphibians	Toad	22	5	54	79	90	0	.007
Carnivorous Reptiles	Snake	40	22	48	117	72	0	.00334
Domestic Animals	Cattle	453,590	12,000	7	59,292	2	4	50.6
	Chicken	2,000	300	22	1,591	16	19	.484
	Dog	13,000	NA	NA	5,715	8	11	3.06

NA = Not applicable or not available

Table L-19
Representative wildlife species diet items[1]

Representative Species	Water	Vegetation	Seeds	Insects	Berries	Mouse	Toad	Fish
Birds								
Flicker	.02	0	0	15	0	0	0	0
Mourning Dove	.05	0	11	0	0	0	0	0
Jay	.05	0	5	5	4	0	0	0
Kingfisher	.08	0	0	0	0	0	0	50
Screech Owl	.05	0	0	0	0	20	0	0
Mammals								
Mouse	.05	1	2	3	0	0	0	0
Rabbit	.05	130	0	0	0	0	0	0
Deer	1.5	2500	0	0	0	0	0	0
Fox	.8	0	0	0	175	300	0	0
Amphibian								
Toad	.05	0	0	5	0	0	0	0
Reptile								
Snake	.01	0	0	0	0	0	22	0
Domestic Animals								
Cow	58	12000	0	0	0	0	0	0
Chicken	.10	0	300	0	0	0	0	0
Dog	.50	0	0	0	0	0	0	0

---

[1] Consumption in liters for water and in grams for all other items.

Amitrole

Amitrole is very slightly toxic to birds and mammals based on acute oral LD_{50}s ranging from greater than 1,750 mg/kg in cats to greater than 14,700 mg/kg in mice (Table L-20). The 8-day dietary LC_{50} of amitrole in Japanese quail, mallards, and ring-necked pheasants is greater than 5,000 ppm (USDA, 1984). Toxic effects in birds include muscle incoordination, weakness, and slight wing-drop (Hudson et al., 1984). No reproductive or teratogenic effects were caused by amitrole in mice or rats (EPA, 1984a). However, depressed reproduction was observed in mallards fed dose levels 25 percent below the lethal dose (USDA, 1984). Chicken eggs injected with amitrole exhibited toxic effects at 100 ppm in one study and malformations of the beak and tibia at 40 mg/egg in another study (USDA, 1984). The LC_{50} of eggs immersed in an aqueous solution of amitrole is 176 lb/A, which is 22 times greater than the recommended application level (Hoffman and Albers, 1984). Amitrole is primarily excreted unchanged in the urine and does not appear to bioaccumulate in the tissues of animals (USDA, 1984).

Table L-20
Acute oral toxicity of amitrole to birds and mammals

Species	LD_{50} (mg/kg)
Rat	> 4,080
Mouse	>14,700
Rabbit	>10,000
Cat	> 1,750
Mallard	> 2,000

Source: EPA, 1984a; Hudson et al., 1984.

Asulam

Asulam is slightly toxic to birds and mammals based on acute oral LD_{50}s ranging from greater than 2,600 mg/kg for the partridge to greater than 4,000 mg/kg for the rat, rabbit, guinea pig, mallard, pheasant, and pigeon (EPA, 1984b; WSSA, 1983). Technical asulam is not a primary skin and eye irritant or a dermal sensitizer in guinea pigs and rabbits (EPA, 1984b). Asulam was not teratogenic in rats or rabbits, but did cause reproductive effects (decreased mean number of live births per litter) in rats (EPA, 1984b). Bobwhite quail fed asulam at levels of 25 ppm in the diet for 28 days showed no changes in food consumption, growth rate, and mortality (Gallo et al., 1975). No reproductive or teratogenic effects were caused by treatment.

Atrazine

Atrazine is of low toxicity to birds and mammals based on acute oral LD_{50}s ranging from 940 mg/kg in bobwhite quail to 4,237 mg/kg in Japanese quail (Table L-21) (EPA, 1983d; EPA, 1984c). Toxic effects in mammals include sedation, labored breathing, ruffled fur, and protruding eyeballs (EPA, 1984c). Atrazine did not cause irritation or sensitization of the skin in rabbits and guinea pigs, but was irritating to the eyes of rabbits (EPA, 1984c). In a 28-day feeding study, body weight loss was observed in sheep at the lowest dose tested of 50 mg/kg/day of the Atrazine 80W formulation (EPA, 1984c). In another study, no effects were observed in sheep given 25 mg/kg/day for 35 days (EPA, 1984c). No adverse effects were observed in ewes treated with 15 mg/kg/day throughout pregnancy (USDA, 1984), and no teratogenic or reproductive effects have been reported for mice and rats (EPA, 1984c).

Avian toxic effects from atrazine include weakness, hyperexcitability, muscle incoordination, tremors, and weight loss (Hudson et al., 1984). Eight-day dietary LC_{50}s for the 99-percent active ingredient were all greater than 5,000 ppm in Japanese quail, bobwhite quail, pheasants, and mallards (EPA, 1983d). Pheasants given 15 weekly doses of AAtrex 80W (80 percent a.i.) showed no change in weight gain, number of eggs laid, eggshell thickness, survival, and weight of offspring (Melius, 1975, as cited in USDA, 1984). Injection of eggs with atrazine caused reduced hatching at 400 ppm (the highest dose tested) (Dunachie and Fletcher, 1970, as cited in USDA, 1984). No teratogenic effects were observed. The LC_{50} of eggs immersed in an aqueous emulsion of atrazine is greater than 400 lb/A, which is greater than the emulsifiable concentrate and is more than 60 times greater than the recommended application rate (Hoffman and Albers, 1984).

Atrazine has a low potential for bioaccumulation in animals and is readily metabolized to nontoxic metabolites and rapidly excreted via the kidneys (USDA, 1984).

Table L-21
Acute oral toxicity of atrazine to birds and mammals

Species	LD_{50} (mg/kg)
Rat	1,869
Mouse	3,992
Japanese quail	4,237
Bobwhite quail	940
Mallard duck	>2,000
Pheasant	>2,000

Source: EPA, 1983d; EPA, 1984c; Hudson et al., 1984

Bromacil

Bromacil is slightly toxic to birds and mammals based on the acute oral LD_{50} of 3,998 mg/kg in rats (EPA, 1984d) and the subacute 8-day dietary LC_{50} of greater than 10,000 ppm in bobwhite quail and mallard ducks (EPA, 1985f). Bromacil caused mild skin and eye irritation in rabbits (EPA, 1984d). No reproductive or teratogenic effects have been observed in rats and rabbits exposed to bromacil (EPA, 1984d). Sheep given oral doses of 50 mg/kg for 10 days experienced an 8-percent reduction in body weight (Palmer and Radeleff, 1969). Based on these results, application rates of greater than 5 lb/A are considered hazardous to sheep.

Chickens given 10 daily doses of 250 mg/kg showed a reduced rate of weight gain (Palmer and Radeleff, 1969). Application rates of 20 lb/A are therefore considered hazardous to chickens.

2,4-D

2,4-D is recognized to be moderately toxic to vertebrate species. Many data exist on the toxicity of various formulations of 2,4-D to vertebrates; there appear to be significant differences among the forms of 2,4-D (amines, butyl esters, isooctyl esters, and propylene glycol butyl ether esters) in terms of toxicity (Ghassemi et al., 1981). In many instances, toxic response to 2,4-D formulations appears to be species-specific. The acute oral LD_{50}s for a variety of birds and mammals are listed in Table L-22. Oral LD_{50}s in mammals range from 100 mg/kg for dogs, cattle, and swine to 848 mg/kg for guinea pigs (USDA, 1984; Ghassemi et al., 1981). Toxic effects include gastrointestinal disturbances, weight loss, muscle weakness, and incoordination (USDA, 1984). Mild to moderate eye, skin, and respiratory irritation is caused by some formulations (USDA, 1984). No teratogenic or reproductive effects have been observed in rats (EPA, 1986d).

In birds, acute oral LD_{50}s range from 472 mg/kg in young pheasants to greater than 2,000 mg/kg in mallards (Hudson et al., 1984). Avian toxic effects include excessive thirst and salivation, tremors, exhaustion, and imbalance (Hudson et al., 1984). Eight-day dietary studies with the dimethylamine salt of 2,4-D and the butoxyethanol ester of 2,4-D yielded LC_{50} values of greater than 5,000 ppm for Japanese quail, bobwhite quail, ring-necked pheasants, and mallard ducks (Hill et al., 1975, as cited in USDA, 1984). No reproductive or teratogenic effects were observed in the eggs of chickens and pheasants when treated with various forms of 2,4-D, even at dosage levels of up to 20 times the recommended field application rate (USDA, 1984). The LC_{50} of mallard eggs immersed in an aqueous emulsion of 2,4-D was 192 lb/A, which is 32 times the field application rate (Hoffman and Albers, 1984).

Animals do not bioaccumulate 2,4-D to any great extent. The 2,4-D that is absorbed is usually eliminated very rapidly in unmetabolized form (Ghassemi et al., 1981). Very few monitoring data exist on 2,4-D levels found in wildlife. However, studies by Erne (1974 and 1975, as cited in DEA, 1986) in Sweden that sampled 2,4-D levels in liver and kidney tissue of 250 animals taken by hunters or found dead during the period from 1968 to 1972 showed residues that ranged from 0.05 to 6 mg/kg.

There is some indication in the literature that after treatment with 2,4-D there is increased palatability and possibly increased toxicity of normally unpalatable weeds. This was observed in ragwort (Senecio jacobaea), Britain's most serious poisonous weed to domestic livestock, after 2,4-D application (Irvine et al., 1977). Increased palatability was thought to be related to an increased water-soluble carbohydrate content. The authors reported that the total unsaturated pyrrolizidine alkaloid content may also be increased by 2,4-D, increasing the plant's toxicity. Based on the results of this study, it was suggested that cattle be withheld from pastures for about 3 weeks after application of 2,4-D. Effects on grazing wildlife have not been observed; however, increased toxicity may be possible.

Table L-22
Acute oral toxicity of 2,4-D to mammals and birds

Species	Form of 2,4-D	LD_{50} (mg/kg)
Rat	Acid	375
	Butyl ester	620
Mouse	Acid	368
	Butyl ester	380
Guinea pig	Acid	469
	Butyl ester	846
Rabbit	Acid	800
	Butyl ester	424
Dog	Acid	100
Cat	Butyl ester	820
Cattle	Butyl ester	100
Swine	Butyl ester	100
Mule deer	Acid	400 to 800
Chicken	Acid	541
	Butyl ester	2,000
Mallard	Acid	>2,000
	Amine (4 lb a.e./gal)	>2,025
Pheasant	Acid	472
Pigeon	Acid	668
Japanese quail	Acid	668
Chukar	Acid	200 to 400

Source: USDA, 1984; Hudson et al., 1984; Ghassemi et al., 1981.

2,4-DP

Technical 2,4-DP is slightly toxic to mammals based on acute oral LD_{50}s of 532 mg/kg in rats and 650 mg/kg in mice (EPA, 1984f). Technical 2,4-DP caused slight eye and dermal irritation in rabbits. The acute oral LD_{50} for the Weedone formulation in rats is 2,200 ± 350 mg/kg. Toxic effects included depression, excessive salivation, and reduced motor activity and coordination. Weedone caused no dermal irritation and slight eye irritation in rabbits. Technical 2,4-DP caused teratogenic effects in rabbits at 25 mg/kg, but showed no effects in rats at 100 mg/kg, the highest dose tested (EPA, 1984f).

Injection of 2,4-DP into chicken eggs caused reduced hatching at 100 ppm and complete inhibition of hatching at 200 ppm (Dunachie and Fletcher, 1970, as cited in USDA, 1984). No other toxicity data are available for avian species; however, assuming the toxicity of 2,4-DP is similar to that of 2,4-D, 2,4-DP would be of low toxicity to birds (USDA, 1984).

Dalapon

Based on acute oral LD_{50}s ranging from 3,860 mg/kg in rabbits and guinea pigs to 7,570 mg/kg in rats, dalapon is of low toxicity to wildlife (EPA, 1984g) (Table L-23). Dalapon causes slight to moderate dermal and eye irritation in rabbits (EPA, 1984g; USDA, 1984). Cattle given oral capsules of 500 mg/kg for 10 days exhibited no adverse effects (Kenaga, 1974, as cited in USDA, 1984). Calves given oral doses of 1,000 mg/kg for 10 days experienced diarrhea, anorexia, weight loss, slowed pulse rate, and mucous discharge (Paynter et al., 1960, as cited in USDA, 1984). Calves showed no adverse effects when fed grass and oats treated with up to 30 lb/A (USDA, 1984).

Sheep given daily oral capsules of 100 mg/kg for 10 and 481 days showed 6 percent and 10 percent weight loss respectively (Kenaga, 1974, as cited in USDA, 1984). However, in another study, sheep given daily oral doses of 100 mg/kg for 35 days showed no ill effects (Paynter et al., 1960, as cited in USDA, 1984). Sheep fed oats treated with up to 20 lb/A exhibited no adverse effects (USDA, 1984).

Dalapon caused no teratogenic or reproductive effects in rats (EPA, 1984g). Dalapon is rapidly excreted in the urine after ingestion, and very few residues remain in tissues of animals (USDA, 1984).

Dalapon is very slightly toxic to birds based on the acute oral LD_{50} of 5,660 mg/kg in chickens (EPA, 1984g). The subacute dietary LC_{50} is greater than 5,000 ppm for Japanese quail, ring-necked pheasants, and mallard ducks (Hill et al., 1975, as cited in USDA, 1984). The NOEL for chickens given oral doses of dalapon for 10 days is 100 mg/kg/day, based on decreased weight gain at the 250 and 500 mg/kg dose levels (Palmer and Radeleff, 1969, as cited in USDA, 1984). Ten percent mortality was observed in adult pheasants given 5,000 ppm (250 mg/kg/day) in the diet for 10 days (USDA, 1984). High mortality rates (up to 95 percent) were observed in pheasants, mallards, and bobwhites given 5,000 ppm in the diet for 24 to 169 days (USDA, 1984).

Table L-23
Acute oral toxicity of dalapon to mammals and birds

Species	LD_{50} (mg/kg)
Rat	7,570
Mouse	4,600
Guinea pig	3,860
Rabbit	3,860
Chicken	5,660

Source: EPA, 1984g

Dalapon has been observed to cause depressed reproduction in mallards fed levels of less than 25 percent the lethal dose (USDA, 1984). Female mallards and pheasants given 1,000 to 5,000 ppm in the diet laid fewer eggs, although female bobwhites showed no change in the number of eggs laid (USDA, 1984). No effects on hatching success or viability were observed in eggs of treated females. Chicken eggs injected with dalapon showed decreased hatching rates at concentrations of 300 ppm or more (Dunachie and Fletcher, 1970, as cited in USDA, 1984). The LC_{50} of mallard eggs immersed in an aqueous solution of dalapon in greater than 375 lb/A, which is more than 25 times greater than the field application rate (Hoffman and Albers, 1984).

Dicamba

Technical dicamba is slightly toxic to mammals based on oral LD_{50}s of 757 mg/kg in rats and 1,189 mg/kg in mice (USDA, 1984). The oral LD_{50} for guinea pigs is 3,000 mg/kg and for rabbits is 2,000 mg/kg (HSDB, 1987a). Technical dicamba caused mild dermal irritation and mild to moderate eye irritation in rabbits (EPA, 1984h). The acute oral LD_{50} of the Banvel formulation is 1,707 mg/kg in rats (USDA, 1984). Banvel showed a moderate potential for causing dermal sensitization in guinea pigs (EPA, 1984h). Five doses of 250 mg/kg of the Banvel D formulation and 10 daily doses of 250 mg/kg caused no adverse effects in sheep (USDA, 1984). However, two doses of 500 mg/kg of Banvel D caused death in sheep, although 1 dose of 1,000 mg/kg caused no adverse effects (USDA, 1984). Dicamba has not been observed to be teratogenic in rats and rabbits (EPA, 1984h); however, reproductive effects may occur at levels above 2.5 mg/kg (EPA, 1985d).

The EPA (1983e) has characterized technical dicamba and formulated dicamba acid and its salts as practically nontoxic to avian wildlife in dietary exposures. The avian 8-day dietary LC_{50} of technical dicamba acid is greater than 10,000 ppm in both bobwhite quail and the mallard duck (EPA, 1983e). An acute oral LD_{50} of 673 mg/kg was reported for technical dicamba in pheasants (USDA, 1984). The acute oral LD_{50}s of the formulated products were all greater than 2,510 mg/kg in the mallard duck, and the 8-day dietary LC_{50}s were all greater than 4,640 ppm in the mallard and the bobwhite quail (EPA, 1983e).

No teratogenic effects were observed in chicken eggs injected with dicamba; however, hatching success was reduced at the highest dose tested of 400 ppm (USDA, 1984). The LC_{50} of mallard eggs immersed in an aqueous solution of dicamba was greater than 200 lb/A which is more than 200 times the recommended field application level (Hoffman and Albers, 1984). However, eye malformations and stunted growth were observed at levels below the reported LC_{50}.

Diuron

Diuron is slightly toxic to mammals based on the acute oral LD_{50} of 3,750 mg/kg in rats (EPA, 1986a). CNS depression was observed in mammals at high doses. Diuron was not irritating to the eyes and skin of rabbits in primary irritation studies (EPA, 1986a). Diuron did not cause teratogenic or reproductive effects in rats (EPA, 1986a). According to Palmer and Radeleff (1969), application rates of up to 9.6 lb/A would not be dangerous to sheep or cattle.

Diuron is very slightly toxic to birds based on the oral LD_{50} of greater than 2,000 mg/kg in mallard ducks (EPA, 1983f). Signs of toxicity included incoordination and frequent falling (Hudson et al., 1984). The subacute dietary LC_{50} is greater than 5,000 ppm in mallards and ring-necked pheasants, and is 1,730 ppm in bobwhite quail (EPA, 1983f). Diuron is toxic to chickens at relatively low doses (Palmer and Radeleff, 1969). Chickens experienced decreased weight gain at the lowest dose tested of 10 mg/kg for 10 days. All chickens died after 9 doses of 250 mg/kg. Application rates of greater than 1 lb/A were therefore considered hazardous to chickens.

Fosamine

Fosamine is very slightly toxic to mammals based on acute oral LD_{50} values of 24,400 mg/kg in rats, 7,380 mg/kg in guinea pigs, and greater than 15,000 mg/kg in dogs for the Krenite formulation (41.5 percent active ingredient) (DuPont, 1983; USDA, 1984). Krenite caused mild to moderate skin irritation and no eye irritation in rabbits (DuPont, 1983). The acute oral LD_{50} of the Krenite S formulation (Krenite with surfactant added) is greater than 5,000 mg/kg in rats (DuPont, 1983). Krenite S is not a dermal irritant and is a moderate to severe eye irritant in rabbits (DuPont, 1983). Sheep given Krenite in the diet for 90 days showed no adverse effects at doses of up to 2,500 ppm, the highest dose tested (Schneider and Kaplan, 1983, as cited in USDA, 1984). Unformulated fosamine and Krenite were not teratogenic in rats (USDA, 1984).

Unformulated fosamine is very slightly toxic to birds based on acute oral LD_{50}s of greater than 5,000 mg/kg in mallard ducks and bobwhite quail (Schneider and Kaplan, 1983, as cited in USDA, 1984). The 8-day dietary LC_{50} of unformulated fosamine is greater than 10,000 ppm in mallards and bobwhite quail (Schneider and Kaplan, 1983, as cited in USDA, 1984). The acute oral LD_{50} of formulated fosamine is greater than 10,000 mg/kg in the bobwhite quail and the mallard duck (DuPont, 1983).

Glyphosate

Glyphosate is generally recognized to be of low toxicity in the environment. Acute oral LD_{50}s are 4,320 mg/kg for the rat and 3,800 mg/kg for rabbit (EPA, 1984k; USDA, 1984). Based on these values glyphosate can be considered slightly toxic.

Oral LD_{50} values for the Roundup and Rodeo formulations in rats are 5,400 mg/kg and greater than 5,000 mg/kg, respectively (Monsanto, 1983 and 1985). The oral LD_{50} of Roundup in the goat is 4,860 mg/kg (Monsanto, 1985). Glyphosate, Roundup, and Rodeo are practically nontoxic or slightly toxic to the eyes and skin of rabbits (Monsanto, 1983 and 1985). No reproductive or teratogenic effects have been caused by glyphosate in rats or rabbits (EPA, 1984k).

Studies conducted on black-tailed deer and small mammal populations in the Pacific Northwest showed no obvious adverse effects caused by the use of glyphosate for vegetation management during the first year after treatment (Sullivan, 1985). However, in the following years, changes in the composition of small mammal communities occurred in close association with vegetative succession caused by glyphosate application. No adverse effects on reproduction, growth, or survival were observed in populations of deer mice during the year following treatment.

Glyphosate is slightly toxic to birds based on the acute oral LD_{50} of greater than 2,000 mg/kg in bobwhite quail (EPA, 1986e). The 8-day dietary LC_{50} is greater than 4,000 ppm for both mallard ducks and bobwhite quail (EPA, 1986e). Avian reproduction studies yielded no reproductive effects at dietary exposure levels of up to 1,000 ppm (EPA, 1986e).

Through alteration of habitat, glyphosate caused changes in habitat use, density, and foraging behavior of at least four species of nesting birds (Sullivan, 1985). Most species returned to prespray foraging behavior within 2 years at which time vegetation conditions were comparable to those present before treatment.

Residue and metabolism studies have indicated that glyphosate is only slowly absorbed across the gastrointestinal membranes, and that, in the vertebrates tested, there is minimum tissue retention and rapid elimination of residues (Monsanto, 1982).

Hexazinone

Based on toxicity data for birds and mammals, hexazinone presents a low hazard to wildlife species (EPA, 1982e). The acute oral LD_{50} of technical hexazinone is 1,690 mg/kg in rats, 860 mg/kg in guinea pigs, and 2,258 mg/kg in bobwhite quail (EPA, 1984l; EPA, 1982e). The acute oral LD_{50} of a 25-percent hexazinone solution is 6,887 mg/kg in rats (DuPont, 1984). The 8-day dietary LC_{50}s of greater than 10,000 ppm for mallards and greater than 5,000 ppm for bobwhite quail indicate that technical hexazinone is practically nontoxic to birds (EPA, 1982e). Formulated and unformulated hexazinone were irritating to the eyes but not to the skin of rabbits and guinea pigs (USDA, 1984; EPA, 1982e). Hexazinone has not been observed to cause teratogenic or reproductive effects in rats or rabbits (EPA, 1984l; USDA, 1984).

In a study to determine the effects of hexazinone pellets on wildlife, Gridball pellets (10 or 20 percent hexazinone) were placed in the feeding areas of wild or captive rodents, raccoons, skunks, opossums, white-tailed deer, songbirds, and gamebirds (Richmond, 1979, as cited in USDA, 1984). Only one captive prairie vole was observed nibbling and urine-marking pellets. No other animals appeared to be attracted to the Gridballs, and no mortality or unusual behavior was observed.

Picloram

Picloram is slightly toxic to mammals based on acute oral LD_{50}s ranging from greater than 540 mg/kg in calves to 8,200 mg/kg in rats (Table L-24) (Lynn, 1965; Jackson, 1965). Technical picloram caused mild eye and skin irritation in rabbits (EPA, 1984m). Picloram was not teratogenic in rats, rabbits, or mice; however, reduced fertility was observed in rats at 1,000 ppm (50 mg/kg)(EPA, 1984m). The Tordon 101 formulation caused no ill effects in sheep at single doses of 1,900 mg/kg, but caused death at levels of 2,200 mg/kg and above (Lynn, 1965). Temporary weight loss was the only adverse effect seen in calves given Tordon 101 in single doses of 1,900 to 3,163 mg/kg (Lynn, 1965). No toxic signs or adverse effects on growth were observed in sheep given 18 mg/kg/day of technical picloram in the diet for 33 days (Jackson, 1965). Stimulated growth and improved feed efficiency were observed in swine given 22 mg/kg of feed for an unspecified time (McCollister and Leng, 1969). Metabolic and residue studies in mammalian species indicate that picloram is rapidly eliminated unchanged in the urine following ingestion (USDA, 1984). No metabolites have been detected. In addition, picloram does not appear to accumulate to any significant extent in animal tissues (USDA, 1984).

Table L-24
Acute oral toxicity of picloram to mammals and birds

Species	LD_{50} (mg/kg)
Rat	8,200
Mouse	2,000 to 4,000
Rabbit	approx. 4,000
Guinea pig	approx. 3,000
Sheep	> 720
Calf	> 540
Chicken	approx. 6,000
Mallard duck	> 2,000
Pheasant	> 2,000

Sources: Hudson et al., 1984; Jackson, 1965; Lynn, 1965

Picloram is very slightly toxic to birds, based on LD_{50}s ranging from greater than 2,000 mg/kg in mallards and pheasants to approximately 6,000 mg/kg in chickens (Table L-24) (Lynn, 1965; Hudson et al., 1984). Regurgitation occurred shortly after mallards were given treatment, and pheasants exhibited mild muscle incoordination and tremors after treatment (Hudson et al., 1984). Subacute dietary LC_{50}s for bobwhite and Japanese quail, ring-necked pheasants, and mallard ducks were all greater than 5,000 ppm (HSDB, 1987b). The 8-day dietary LC_{50} of the Tordon 101 formulation is greater than 10,000 ppm for the bobwhite quail and mallard duck (EPA, 1984q).

Japanese quail given 100 ppm in a 2-week dietary study showed no effects on feathering, reproduction, mortality, and weight (Kenaga, 1969). In a similar test at 1,000 ppm, egg fertility and hatchability were reduced the first week but not the second (Kenaga, 1969). A 3-generation study with Japanese quail showed no effects on food consumption, reproduction, survival, and body weight when given 100, 500, or 1,000 ppm in the diet (Kenaga, 1969). In a 1-year study in which Japanese quail were given 100 ppm to 10,000 ppm in their diet, no effects on reproduction, feeding, or body weights were observed. Mortality rates of treated quail were lower than those of controls (Kenaga, 1969).

The LC_{50} of mallard eggs immersed in an aqueous emulsion of picloram was 100 lb/A, which is more than 10 times greater than the recommended field application level (Hoffman and Albers, 1984). Spray treatment of chicken eggs or ring-necked pheasant eggs with a dose equivalent to 2.8 kg/ha of Tordon 101 did not affect embryonic development or subsequent growth of hatched chicks (EPA, 1984q).

Simazine

Simazine is slightly toxic to birds and mammals based on acute oral LD_{50}s ranging from 2,010 mg/kg in gray-tailed voles to greater than 5,000 mg/kg in rats, mice, and rabbits (Table L-25) (EPA, 1983i; USDA, 1984). Simazine is slightly irritating the the eyes but not to the skin of rabbits (USDA, 1984). No teratogenic or reproductive effects have been observed in rats (EPA, 1986b). Subchronic oral toxicity studies in cattle showed weight loss and toxic symptoms such as depression, muscular spasms, incoordination, and weakness when given doses ranging from 20 mg/kg/day for 6 days to 50 mg/kg/day for 10 days (Palmer and Radeleff, 1969, as cited in USDA, 1984). Cattle given 7 doses of 100 mg/kg/day became moribund; however, cattle given 3 doses of 250 g/kg/day showed weight loss but no other toxic signs. Sheep showed signs of intoxication and weight loss when given one dose of 250 mg/kg and 10 doses of 50 mg/kg/day (Palmer and Radeleff, 1969, as cited in USDA, 1984). Sheep died when given 10 doses of 100, 250, or 400 mg/kg/day.

Simazine did not bioaccumulate and was rapidly excreted in the urine and feces in rat metabolism studies (EPA, 1986b).

Table L-25
Acute oral toxicity of simazine in birds and mammals

Species	LD_{50} (mg/kg)
Rat	>5,000
Mouse	>5,000
Rabbit	>5,000
Prairie vole	3,920 (males) 3,980 (females)
Gray-tailed vole	2,010 (males) 2,690 (females)
Mallard duck	>4,640

Source: USDA, 1984; EPA, 1983i

Dietary LC_{50}s of greater than 5,000 ppm in bobwhite quail, ring-necked pheasants and mallards and greater than 3,720 ppm in Japanese quail indicate low toxicity to birds (EPA, 1983i). An 11-week dietary study reported an LC_{50} of greater than 2,000 ppm for bobwhite quail. LC_{50}s of 11,000 ppm and greater than 32,000 ppm were reported for the 80-percent WP formulation in bobwhite quail and mallards, respectively. In a 1-generation reproduction study with mallards, no reproductive impairment occurred at 20 ppm, the highest dose tested (EPA, 1983i). Chicken eggs injected with simazine in an acetone solution exhibited decreased hatchability at 300 ppm, but not at 200 ppm or less (Dunachie and Fletcher, 1970, as cited in USDA, 1984). Based on the available information, EPA (1983i) concluded that simazine was practically nontoxic and will not affect reproduction in birds.

In subacute oral toxicity studies, doses of up to 1,500 ppm produced no lethal effects in mallards and bobwhites (Meyerhoff, 1981, as cited in USDA, 1985). In a 30-day oral study, chickens exhibited depressed growth at 2,500 ppm (EPA, 1986c). In 18-, 24-, and 27-week studies, no effects on growth, reproduction, or behavior were observed in bobwhite quail or mallard ducks when fed up to 100 ppm in the diet (Elanco Products Company, 1983 and undated, as cited in USDA, 1985).

Tebuthiuron

Tebuthiuron is moderately to slightly toxic to birds and mammals based on acute oral LD_{50}s ranging from 186 mg/kg in rabbits to greater than 2,000 mg/kg in mallards and bobwhites (Table L-26) (EPA, 1986c; USDA, 1985). Tebuthiuron is slightly irritating to the eyes but not to the skin of rabbits (EPA, 1986c). However, no other reproductive or teratogenic effects were observed in rats and rabbits in other studies. In subchronic oral toxicity studies, dogs experienced increased thyroid and spleen weight at 25 mg/kg (EPA, 1986c). Decreased body weight was observed in cattle at 100 ppm in a 162-day study (EPA, 1986c). Tebuthiuron is readily metabolized and eliminated in the urine of animals (USDA, 1985).

Table L-26
Acute oral toxicity of tebuthiuron in birds and mammals

Species	LD_{50} (mg/kg)
Rat	644
Mouse	579
Rabbit	286
Dog	>500
Cat	>200
Bobwhite quail	>2,000
Mallard duck	>2,000
Chicken	>500

Source: USDA, 1985; EPA, 1983i.

In subacute oral toxicity studies, doses of up to 1,500 ppm produced no lethal effects in mallards and bobwhites (Meyerhoff, 1981, as cited in USDA 1985). In a 30-day oral study, chickens exhibited depressed growth at 2,500 ppm (EPA, 1986c). In 18-, 24-, and 27-week studies, no effects on growth, reproduction, or behavior were observed in bobwhite quail or mallard ducks when fed up to 100 ppm in the diet (Elanco Products Company, 1983 and undated, as cited in USDA, 1985).

Triclopyr

Triclopyr is moderately toxic to mammals based on LD_{50}s ranging from 310 mg/kg in guinea pigs to 729 mg/kg in male rats (Table L-27) (EPA, 1985j). Technical triclopyr is slightly irritating to the eyes and skin of rabbits (EPA, 1985j). The Garlon 3A and Garlon 4 formulations are slightly toxic with oral LD_{50}s of 2,830 and 2,140 mg/kg in rats (males and females, respectively) (Dow Chemical Company, undated). Garlon 3A may cause slight to moderate eye and skin irritation, and Garlon 4 may cause slight skin irritation but no eye irritation (Dow Chemical Company, undated). Ponies exposed to 4 daily doses of 60 mg/kg of triclopyr exhibited no adverse effects; however, exposure to 4 daily doses of 300 mg/kg caused depression, decreased gastrointestinal activity, and respiratory and muscular distress (Osweiler, 1983).

No teratogenic or reproductive effects have been observed in rats and rabbits (EPA, 1985j). Triclopyr is rapidly excreted, primarily as the parent compound, through the kidneys in animals (USDA, 1984). Small quantities of two other compounds are also excreted. Triclopyr does not appear to bioaccumulate in animal tissues in any significant amount (Dow Chemical Company, 1987b).

Based on acute oral and dietary studies, triclopyr, Garlon 3A, and Garlon 4 are very slightly toxic to birds (Table L-27). The acute oral LD_{50} of technical triclopyr is 1,698 mg/kg for mallard ducks, and the dietary LC_{50} ranges from 2,935 to greater than 5,000 ppm (Dow Chemical Company, undated; Kenaga, 1979). The dietary LC_{50}s of Garlon 3A and Garlon 4 are all greater than 9,000 ppm (Dow Chemical Company, undated). A 1-generation reproduction study showed no reproductive effects, symptoms of toxicity, or abnormal behavior when mallards were given up to 500 ppm in the diet for 10 weeks prior to egg laying and 10 weeks during egg laying (Dow Chemical Company, 1987b). A similar study reported no reproductive or toxic effects in bobwhite quail exposed to dietary levels of up to 500 ppm for 11 weeks prior to egg laying and 8 weeks during egg laying (Dow Chemical Company, 1987b).

Table L-27
Acute toxicity of triclopyr in birds and mammals

Species	Formulation	Test	Results
Rat	Technical	Oral LD_{50}	729 mg/kg (male) 630 mg/kg (female)
Mouse	Technical	Oral LD_{50}	471 mg/kg
Rabbit	Technical	Oral LD_{50}	550 mg/kg
Guinea pig	Technical	Oral LD_{50}	310 mg/kg
Rat	Garlon 3A	Oral LD_{50}	2,830 mg/kg (male) 2,140 mg/kg (female)
	Garlon 4	Oral LD_{50}	2,460 mg/kg (male) 2,140 mg/kg (female)
Mallard duck	Technical	Oral LD_{50}	1,698 mg/kg
		Dietary LC_{50}	>5,000 ppm
	Garlon 3A	Dietary LC_{50}	>10,000 ppm
	Garlon 4	Dietary LC_{50}	>10,000 ppm
Japanese quail	Technical	Dietary LC_{50}	3,278 ppm
Bobwhite quail	Technical	Dietary LC_{50}	2,935 ppm
	Garlon 3A	Dietary LC_{50}	11,622 ppm
	Garlon 4	Dietary LC_{50}	9,026 ppm

Source: EPA, 1985j; Dow Chemical Company, undated; Kenaga, 1979

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AQUATIC RISK ANALYSIS

The risks of adverse effects from exposure to herbicides were estimated for a variety of aquatic organisms under the various application scenarios (including accidents) described in the human health risk analysis.

Representative acute toxicity reference values (LC_{50}s or EC_{50}s) and chronic toxicity reference values (MATCs or NOELs) were derived from the summary tables presented in the aquatic hazard analysis for the following groups of organisms: warmwater fish (including bluegill, fathead minnow, and catfish), coldwater fish (e.g. rainbow trout), microcrustaceans (including water fleas, copepods, scuds, sowbugs, seed shrimp, and fairy shrimp), insects (including stoneflies, mayflies, dragonflies, and midges), molluscs (claims and snails), crayfish, and amphibians (tadpoles).

These toxicity reference values were compared to the estimated environmental concentrations (EECs) for each chemical under each scenario. The ratio of the EEC to the LC_{50} (or EC_{50}) is the quotient value (Q-value).

The Q-values (EEC/LC_{50}) were compared to the risk criteria proposed by EPA (1986) where the risks of effects to fish or invertebrates are described as follows:

Q-value		Risk
EEC/LC_{50}	< 0.1	No acute risk.
EEC/LC_{50}	≥ 0.1 and ≤ 0.5	Presumption of risk that may be mitigated.
EEC/LC_{50}	≥ 0.5	Presumption of significant risk of acute effects.
EEC < NOEL or MATC		No chronic risk.

Results of the Risk Analysis

The amount of herbicide reaching a body of water depends primarily on the application method and the application rate. In this analysis the lowest estimated concentrations were in the highly unlikely right-of-way scenario and the highest values (not including accidents) were in the highly unlikely aerial application scenario. The range of estimated concentrations of the herbicides in water are in Table L-26.

For typical right-of-way operations the estimated herbicide concentrations in water are 1.9 to 7.4 ppb. There are no significant risks of acute or chronic effects to any fish or invertebrate from any of the herbicides under this scenario.

Herbicide concentrations range from 2.1 to 16.6 ppb in the highly unlikely backpack spraying operations. In this scenario there is also no significant risk of acute or chronic effects to aquatic organisms from any of the herbicides. There is a very slight chance (Q-value = .104) of acute adverse effects from diuron to the scud (Gammarus fasciatus) which is

Table L-28
Range of herbicide concentrations (ppb) in water under the three scenarios.

Pesticide	Highly Unlikely R.O.W.	Highly Unlikely Backpack	Highly Unlikely Aerial
AMITROLE	3.7	8.3	---
ASULAM	4.5	5.0	---
ATRAZINE	5.6	12.4	177.0
BROMACIL	7.4	16.6	---
DALAPON	7.4	16.6	---
DICAMBA	1.9	2.1	---
DIURON	7.4	16.6	---
FOSAMINE	7.4	12.4	---
HEXAZINONE	4.7	4.6	118.0
PICLORAM	1.9	4.2	47.1
RODEO	3.7	6.2	---
ROUNDUP	3.7	6.2	---
SIMAZINE	3.7	8.3	---
TEBUTHIURON	4.1	6.2	---
TRICLOPYR	3.7	8.3	94.2
2,4-D	4.7	8.3	118.0
2,4-DP	4.7	8.3	---

highly sensitive to this herbicide. Sensitive trout species are at slight risk of reproductive effects from exposure to picloram.

Aerial applications result in much higher estimates of herbicide concentrations in water than the right-of-way or backpack spraying operations. Estimated aquatic concentrations are 47.1 to 118.0 ppb for highly unlikely aerial operations.

Under highly unlikely assumptions for aerial applications of atrazine, larvae of warmwater fish and amphibians are at significant risk of death and teratogenic effects (see Table L-29). Also, trout fry may be at significant risk of adverse effects from exposure to picloram. However, the chronic effect level used in the analysis for picloram is based on the technical material since no chronic or reproductive studies are available on Tordon 101, and by extrapolating from the technical material to the Tordon 101 mixture the reliability of the estimated risk is reduced. No other significant risks from highly unlikely aerial applications are expected.

Under aerial applications of atrazine, larvae of fish and amphibians are at significant risk of death and teratogenic effects. Trout are at significant risk of adverse effects to fry from exposure to picloram. Drift and run-off from a 400-acre 2,4-D aerial treatment area could produce adverse effects on microcrustaceans and molluscs. No other significant risks from aerial operations are expected based on the estimated Q-values.

Accidents

Herbicide concentrations in water due to the various types of accidents are given in Table L-30. Herbicide concentrations would be relatively low (0.086-0.230 ppm) from a helicopter accidentally dumping its pesticide load into a reservoir. No significant adverse effects would be expected to occur except in the cases of atrazine, where some fish species could experience adverse acute and reproductive effects, and picloram where adverse reproductive effects could occur in trout.

Accidents resulting from a truck spill into a reservoir, direct spraying of a water body, or a helicopter dump into a pond would result in moderately high concentrations of herbicides (0.62-11.7 ppm) in water. These concentrations would normally cause adverse effects in many aquatic organisms. Table L-31 summarizes the risks of acute and chronic effects due to a helicopter dumping its pesticide load into a pond; this scenario represents the highest expected concentrations of these three types of accidents.

An accidental spill of a trucks' pesticide load into a pond is the extreme-case accident and would result in the highest herbicide concentrations (18-110.4 ppm) in water of any of the scenarios. Adverse effects would likely occur in at least some groups of aquatic organisms from any of the herbicides. The risk of adverse effects is given in Table L-32. Direct fish kills would probably occur from any of the herbicides except Rodeo!, fosamine, asulam, tebuthiuron, and bromacil.

Table L-29
Risks to aquatic organisms from highly unlikely aerial operations.

SCENARIO	HERBICIDE[a]	LC_{50} [b] (PPB)	EEC (PPB)	Q-VALUE (EEC/LC_{50})	RISK[c]
	ATRAZINE				
WARMWATER FISH:		220	177	0.805	SIGNIFICANT
COLDWATER FISH:		870	177	0.203	SLIGHT
MICROCRUSTACEA:		1,000	177	0.177	SLIGHT
INSECTS:		720	177	0.246	SLIGHT
MOLLUSCS:		500	177	0.354	SLIGHT
CRAYFISH:		---	177	---	NO DATA
AMPHIBIANS:		310	177	0.571	SIGNIFICANT
CHRONIC TOX.:		50	177	3.540	SIGNIFICANT
	HEXAZINONE				
WARMWATER FISH:		274,000	118	0.000	NO RISK
COLDWATER FISH:		100,000	118	0.001	NO RISK
MICROCRUSTACEA:		56,000	118	0.002	NO RISK
INSECTS:		---	118	---	NO DATA
MOLLUSCS:		320,000	118	0.000	NO RISK
CRAYFISH:		1,000,000	118	0.000	NO RISK
AMPHIBIANS:		---	118	---	NO DATA
CHRONIC TOX.:		10,000	118	0.012	NO RISK
	PICLORAM				
WARMWATER FISH:		3,700	47.1	0.013	NO RISK
COLDWATER FISH:		8,600	47.1	0.005	NO RISK
MICROCRUSTACEA:		380,000	47.1	0.000	NO RISK
INSECTS:		---	47.1	---	NO DATA
MOLLUSCS:		380,000	47.1	0.000	NO RISK
CRAYFISH:		---	47.1	---	NO DATA
AMPHIBIANS:		---	47.1	---	NO DATA
CHRONIC TOXICITY:		35	47.1	1.346	SIGNIFICANT[d]
	TRICLOPYR				
WARMWATER FISH:		870	94.2	1.108	SLIGHT
COLDWATER FISH:		740	94.2	1.127	SLIGHT
MICROCRUSTACEA:		1,170,000	94.2	0.000	NO RISK
INSECTS:		---	94.2	---	NO DATA
MOLLUSCS:		56,000	94.2	0.002	NO RISK
CRAYFISH:		1,000,000	94.2	0.000	NO RISK
AMPHIBIANS:		---	94.2	---	NO DATA
CHRONIC TOX.:		110,000	94.2	0.001	NO RISK

Table L-29 (Cont.)

SCENARIO	HERBICIDE[a]	LC50[b] (PPB)	EEC (PPB)	Q-VALUE (EEC/LC_{50})	RISK[c]
	2,4-D				
WARMWATER FISH:		1,200	118	0.098	NO RISK
COLDWATER FISH:		1,420	118	0.083	NO RISK
MICROCRUSTACEA:		440	118	0.268	SLIGHT
INSECTS:		1,600	118	0.074	NO RISK
MOLLUSCS:		3,750	118	0.031	NO RISK
CRAYFISH:		100,000	118	0.001	NO RISK
AMPHIBIANS:		---	118	---	NO DATA
CHRONIC TOXICITY:		320	118	0.369	NO RISK

[a] Only the five listed herbicides are proposed for aerial use.

[b] For acute toxicity the 96-hr LC_{50} or EC_{50} was used. For chronic toxicity the lowest NOEL or maximum acceptable toxicant concentration (MATC) from a fish or invertebrate study was used as a reference value.

[c] Slight risk indicates the Q-value is between 0.1 and 0.5 and the risk can be mitigated.

[d] Chronic effect level is based on technical picloram.

Table L-30
Herbicide concentrations (ppm) in water from accidents.

	Helicopter Dump into Reservoir	Truck Spill into Reservoir	Direct Spraying	Helicopter Dump into Pond	Truck Spill into Pond
AMITROLE	----[a]	1.1508	5.87	----	36.8255
ASULAM	----	0.9699	3.67	----	30.7493
ATRAZINE	0.1151	1.1508	6.24	3.6825	36.8255
BROMACIL	----	0.5754	7.34	----	18.4127
DALAPON	----	2.8770	7.34	----	92.0636
DICAMBA	----	1.1508	2.93	----	36.8255
DIURON	----	0.9206	11.74	----	29.4604
FOSAMINE	----	3.4524	8.80	----	110.4764
GLYPHOSATE	----	1.4385	3.67	----	46.0318
HEXAZINONE	0.0863	0.8631	4.40	2.7619	27.6191
PICLORAM	0.1438	1.4385	3.67	4.6032	46.0318
SIMAZINE	----	1.4385	3.67	----	46.0318
TEBUTHIURON	----	1.7262	4.40	----	55.2382
TRICLOPYR	0.2302	2.3016	5.87	7.3651	73.6509
2,4-D	0.1151	1.1508	3.01	3.6825	36.8255
2,4-DP	----	0.7192	3.67	----	23.0159

[a] Not proposed for aerial use.

Table L-31
Risk of adverse effects to aquatic organisms from a helicopter spill of herbicide into a pond.

SCENARIO	HERBICIDE[a]	LC_{50} (PPB)	EEC (PPB)	Q-VALUE (EEC/LC_{50})	RISK
	ATRAZINE				
WARMWATER FISH:		220	3,682	16.736	SIGNIFICANT
COLDWATER FISH:		870	3,682	4.232	SIGNIFICANT
MICROCRUSTACEA:		1,000	3,682	3.682	SIGNIFICANT
INSECTS:		720	3,682	5.114	SIGNIFICANT
MOLLUSCS:		500	3,682	7.364	SIGNIFICANT
CRAYFISH:		---	3,682		NO DATA
AMPHIBIANS:		310	3,682	11.877	SIGNIFICANT
CHRONIC TOX.:		50	3,682	73.640	SIGNIFICANT
	HEXAZINONE				
WARMWATER FISH:		274,000	2,762	0.010	NO RISK
COLDWATER FISH:		100,000	2,762	0.028	NO RISK
MICROCRUSTACEA:		56,000	2,762	0.049	NO RISK
INSECTS:		---	2,762	---	NO DATA
MOLLUSCS:		320,000	2,762	0.009	NO RISK
CRAYFISH:		1,000,000	2,762	0.003	NO RISK
AMPHIBIANS:		---	2,762	---	NO DATA
CHRONIC TOX.:		10,000	2,762	0.276	NO RISK
	TORDON 101				
WARMWATER FISH:		3,700	4,603	1.244	SIGNIFICANT
COLDWATER FISH:		8,600	4,603	0.535	SIGNIFICANT
MICROCRUSTACEA:		380,000	4,603	0.012	NO RISK
INSECTS:		---	4,603	---	NO DATA
MOLLUSCS:		380,000	4,603	0.012	NO RISK
CRAYFISH:		---	4,603	---	NO DATA
AMPHIBIANS:		---	4,603	---	NO DATA
CHRONIC TOX.:		35	4,603	131.514	SIGNIFICANT

Table L-31 (Cont.)

SCENARIO	HERBICIDE[a]	LC_{50} (PPB)	EEC (PPB)	Q-VALUE (EEC/LC_{50})	RISK
	TRICLOPYR				
WARMWATER FISH:		870	7,365	8.466	SIGNIFICANT
COLDWATER FISH:		740	7,365	9.953	SIGNIFICANT
MICROCRUSTACEA:		1,170,000	7,365	0.006	NO RISK
INSECTS:		---	7,365	---	NO DATA
MOLLUSCS:		56,000	7,365	0.132	SLIGHT
CRAYFISH:		1,000,000	7,365	0.007	NO RISK
AMPHIBIANS:		---	7,365	---	NO DATA
CHRONIC TOX.:		110,000	7,365	0.067	NO RISK
	2,4-D				
WARMWATER FISH:		1,200	3,682	3.068	SIGNIFICANT
COLDWATER FISH:		1,420	3,682	2.593	SIGNIFICANT
MICROCRUSTACEA:		440	3,682	8.368	SIGNIFICANT
INSECTS:		1,600	3,682	2.301	SIGNIFICANT
MOLLUSCS:		3,750	3,682	0.982	SIGNIFICANT
CRAYFISH:		100,000	3,682	0.037	NO RISK
AMPHIBIANS:		---	3,682	---	NO DATA
CHRONIC TOX.:		320	3,682	11.506	SIGNIFICANT

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[a] Only the five listed herbicides are proposed for aerial application.

Table L-32
Risk of adverse effects to aquatic organisms from a
truck spill of herbicide into a pond.

SCENARIO	HERBICIDE	LC_{50} (PPB)	EEC (PPB)	Q-VALUE (EEC/LC_{50})	RISK
	AMITROLE				
WARMWATER FISH:		100,000	36,826	0.368	SLIGHT
COLDWATER FISH:		3,250,000	36,826	0.011	NO RISK
MICROCRUSTACEA:		1,430	36,826	25.752	SIGNIFICANT
INSECTS:		----	36,826	----	NO DATA
MOLLUSCS:		----	36,826	----	NO DATA
CRAYFISH:		100,000	36,826	0.368	SLIGHT
AMPHIBIANS:		3,000,000	36,826	0.012	NO RISK
CHRONIC TOX.:		5,000	36,826	7.365	SIGNIFICANT
	ASULAM				
WARMWATER FISH:		3,000,000	30,749	0.010	NO RISK
COLDWATER FISH:		5,000,000	30,749	0.006	NO RISK
MICROCRUSTACEANS:		----	30,749	----	NO DATA
INSECTS:		----	30,749	----	NO DATA
MOLLUSCS:		----	30,749	----	NO DATA
CRAYFISH:		----	30,749	----	NO DATA
AMPHIBIANS:		----	30,749	----	NO DATA
CHRONIC TOX.:		----	30,749	----	NO DATA
	ATRAZINE				
WARMWATER FISH:		220	36,826	167.391	SIGNIFICANT
COLDWATER FISH:		870	36,826	42.329	SIGNIFICANT
MICROCRUSTACEA:		1,000	36,826	36.826	SIGNIFICANT
INSECTS:		720	36,826	51.147	SIGNIFICANT
MOLLUSCS:		500	36,826	73.652	SIGNIFICANT
CRAYFISH:		----	36,826	----	NO DATA
AMPHIBIANS:		310	36,826	118.794	SIGNIFICANT
CHRONIC TOX.:		50	36,826	736.520	SIGNIFICANT
	BROMACIL				
WARMWATER FISH:		71,000	18,413	0.259	SLIGHT
COLDWATER FISH:		75,000	18,413	0.246	SLIGHT
MICROCRUSTACEA:		40,000	18,413	0.460	SLIGHT
INSECTS:		----	18,413	----	NO DATA
MOLLUSCS:		----	18,413	----	NO DATA
CRAYFISH:		40,000	18,413	0.460	SLIGHT
AMPHIBIANS:		230,000	18,413	0.080	NO RISK
CHRONIC TOX.:		----	18,413	----	NO DATA

Table L-32 (Cont.)

SCENARIO	HERBICIDE	LC_{50} (PPB)	EEC (PPB)	Q-VALUE (EEC/LC_{50})	RISK
	DALAPON				
WARMWATER FISH:		105,000	92,064	0.877	SIGNIFICANT
COLDWATER FISH:		340,000	92,064	0.271	SLIGHT
MICROCRUSTACEA:		6,000	92,064	15.344	SIGNIFICANT
INSECTS:		1,000	92,064	92.064	SIGNIFICANT
MOLLUSCS:		----	92,064	----	NO DATA
CRAYFISH		----	92,064	----	NO DATA
AMPHIBIANS:		4,200,000	92,064	0.022	NO RISK
CHRONIC TOX.:		50,000	92,064	1.841	SIGNIFICANT
	DICAMBA				
WARMWATER FISH:		50,000	36,826	0.737	SIGNIFICANT
COLDWATER FISH:		28,000	36,826	1.315	SIGNIFICANT
MICROCRUSTACEA:		11,000	36,826	3.348	SIGNIFICANT
INSECTS:		----	36,826	----	NO DATA
MOLLUSCS:		----	36,826	----	NO DATA
CRAYFISH:		----	36,826	----	NO DATA
AMPHIBIANS:		106,000	36,826	0.347	SLIGHT
CHRONIC TOX.:		----	36,826	----	NO DATA
	DIURON				
WARMWATER FISH:		8,200	29,460	3.593	SIGNIFICANT
COLDWATER FISH:		1,400	29,460	21.043	SIGNIFICANT
MICROCRUSTACEA:		160	29,460	184.125	SIGNIFICANT
INSECTS:		1,200	29,460	24.550	SIGNIFICANT
MOLLUSCS:		----	29,460	----	NO DATA
CRAYFISH:		----	29,460	----	NO DATA
AMPHIBIANS:		----	29,460	----	NO DATA
CHRONIC TOX.:		----	29,460	----	NO DATA
	FOSAMINE				
WARMWATER FISH:		670,000	110,476	0.165	SLIGHT
COLDWATER FISH:		367,000	110,476	0.301	SLIGHT
MICROCRUSTACEA:		100,000	110,476	1.105	SIGNIFICANT
INSECTS:		----	110,476	----	NO DATA
MOLLUSCS:		----	110,476	----	NO DATA
CRAYFISH:		----	110,476	----	NO DATA
AMPHIBIANS:		----	110,476	----	NO DATA
CHRONIC TOX.:		----	110,476	----	NO DATA

Table L-32 (Cont.)

SCENARIO	HERBICIDE	LC_{50} (PPB)	EEC (PPB)	Q-VALUE (EEC/LC_{50})	RISK
	HEXAZINONE				
WARMWATER FISH:		274,000	27,619	0.101	SLIGHT
COLDWATER FISH:		100,000	27,619	0.276	SLIGHT
MICROCRUSTACEA:		56,000	27,619	0.493	SLIGHT
INSECTS:		----	27,619	----	NO DATA
MOLLUSCS:		320,000	27,619	0.086	NO RISK
CRAYFISH:		1,000,000	27,619	0.028	NO RISK
AMPHIBIANS:		----	27,619	----	NO DATA
CHRONIC TOX.:		10,000	27,619	2.762	SIGNIFICANT
	RODEO				
WARMWATER FISH:		1,000,000	46,032	0.046	NO RISK
COLDWATER FISH:		1,000,000	46,032	0.046	NO RISK
MICROCRUSTACEA:		930,000	46,032	0.049	NO RISK
INSECTS:		----	46,032	----	NO DATA
MOLLUSCS:		----	46,032	----	NO DATA
CRAYFISH:		----	46,032	----	NO DATA
AMPHIBIANS:		----	46,032	----	NO DATA
CHRONIC TOX.:		----	46,032	----	NO DATA
	ROUNDUP				
WARMWATER FISH:		1,300	46,032	35.409	SIGNIFICANT
COLDWATER FISH:		1,800	46,032	25.573	SIGNIFICANT
MICROCRUSTACEA:		3,000	46,032	15.344	SIGNIFICANT
INSECTS:		18,000	46,032	2.557	SIGNIFICANT
MOLLUSCS:		----	46,032	----	NO DATA
CRAYFISH:		1,000,000	46,032	0.046	NO RISK
AMPHIBIANS:		----	46,032	----	NO DATA
CHRONIC TOX.:		----	46,032	----	NO DATA
	SIMAZINE				
WARMWATER FISH:		5,000	46,032	9.206	SIGNIFICANT
COLDWATER FISH:		2,800	46,032	16.440	SIGNIFICANT
MICROCRUSTACEA:		1,100	46,032	41.847	SIGNIFICANT
INSECTS:		1,900	46,032	24.227	SIGNIFICANT
MOLLUSCS:		---	46,032	---	NO DATA
CRAYFISH:		100,000	46,032	0.460	SLIGHT
AMPHIBIANS:		---	46,032	---	NO DATA
CHRONIC TOX.:		2,500	46,032	18.413	SIGNIFICANT

Table L-32 (Cont.)

SCENARIO	HERBICIDE	LC_{50} (PPB)	EEC (PPB)	Q-VALUE (EEC/LC_{50})	RISK
	TEBUTHIURON				
WARMWATER FISH:		112,000	55,238	0.493	SLIGHT
COLDWATER FISH:		144,000	55,238	0.384	SLIGHT
MICROCRUSTACEA:		48,000	55,238	1.151	SIGNIFICANT
INSECTS:		----	55,238	----	NO DATA
MOLLUSCS:		180,000	55,238	0.307	SLIGHT
CRAYFISH:		320,000	55,238	0.173	SLIGHT
AMPHIBIANS:		----	55,238	----	NO DATA
CHRONIC TOX.:		9,300	55,238	5.940	SIGNIFICANT
	TORDON 101				
WARMWATER FISH:		3,700	46,032	12.441	SIGNIFICANT
COLDWATER FISH:		8,600	46,032	5.353	SIGNIFICANT
MICROCRUSTACEA:		380,000	46,032	0.121	SLIGHT
INSECTS:		---	46,032	---	NO DATA
MOLLUSCS:		380,000	46,032	0.121	SLIGHT
CRAYFISH:		---	46,032	---	NO DATA
AMPHIBIANS:		---	46,032	---	NO DATA
CHRONIC TOX.:		35	46,032	1315.2	SIGNIFICANT
	TRICLOPYR				
WARMWATER FISH:		870	73,651	84.656	SIGNIFICANT
COLDWATER FISH:		740	73,651	99.528	SIGNIFICANT
MICROCRUSTACEA:		1,170,000	73,651	0.063	NO RISK
INSECTS:		----	73,651	----	NO DATA
MOLLUSCS:		56,000	73,651	1.315	SIGNIFICANT
CRAYFISH:		1,000,000	73,651	0.074	NO RISK
AMPHIBIANS:		----	73,651	----	NO DATA
CHRONIC TOX.:		110,000	73,651	0.670	NO RISK
	2,4-D				
WARMWATER FISH:		1,200	36,826	30.688	SIGNIFICANT
COLDWATER FISH:		1,420	36,826	25.934	SIGNIFICANT
MICROCRUSTACEA:		440	36,826	83.695	SIGNIFICANT
INSECTS:		1,600	36,826	23.016	SIGNIFICANT
MOLLUSCS:		3,750	36,826	9.820	SIGNIFICANT
CRAYFISH:		100,000	36,826	0.368	SLIGHT
AMPHIBIANS:		----	36,826	----	NO DATA
CHRONIC TOX.:		320	36,826	115.081	SIGNIFICANT

Table L-32 (Cont.)

SCENARIO	HERBICIDE	LC_{50} (PPB)	EEC (PPB)	Q-VALUE (EEC/LC_{50})	RISK
	2,4-DP				
WARMWATER FISH:		1,100	23,016	20.924	SIGNIFICANT
COLDWATER FISH:		1,100	23,016	20.924	SIGNIFICANT
MICROCRUSTACEA:		----	23,016	----	NO DATA
INSECTS:		----	23,016	----	NO DATA
MOLLUSCS:		----	23,016	----	NO DATA
CRAYFISH:		----	23,016	----	NO DATA
AMPHIBIANS:		----	23,016	----	NO DATA
CHRONIC TOX.:		----	23,016	----	NO DATA

AQUATIC HAZARD ANALYSIS

Amitrole

The toxicity of amitrole to aquatic organisms is summarized in Table L-33. Amitrole is only slightly toxic* to fish and crayfish with LC_{50}s generally greater than 100 ppm. Microcrustaceans such as cladocerans (water fleas) and copepods are much more sensitive; the lowest reported 96-hr LC_{50} is 1.43 ppm for *Daphnia magna*.

A formulation of 50 percent amitrole (Weedazol TL Plus) was of low toxicity to frog tadpoles; the 96-hr LC_{50} was 3,000 ppm (Johnson, 1976 in USDA, 1984).

Asulam

Asulam is only slightly toxic to fish. All 96-hr LC_{50} values are greater than 1,700 ppm in the five species of fish tested (Table L-34). No information is available on its toxicity to aquatic invertebrates or amphibians.

Atrazine

Atrazine is moderately to highly toxic to fish and aquatic invertebrates (Table L-35). Early life-stage studies with fish and amphibians have indicated that atrazine is highly acutely toxic and teratogenic. Atrazine also affects reproduction in a number of invertebrates at concentrations of 1 ppm or less.

Bromacil

Bromacil is slightly toxic to aquatic organisms. The LC_{50} values in Table L-36 are all 40 ppm or greater. The most sensitive organisms tested were the water flea and the crayfish. The 48-hr LC_{50} for tadpoles is 230 ppm.

2,4-D

The aquatic toxicity of the butoxyethanol ester of 2,4-D ranges from moderately to highly toxic. Acute LC_{50} values range from about 0.5 ppm to 10 ppm for most species (Table L-37). Amphipods (*Gammarus*) and snails (*Lymnea*) are among the most sensitive groups. The acids, to which esters rapidly hydrolyze, are not nearly as toxic; they are typically 100 times less toxic than the esters (Ghassemi et al., 1981). The toxicity of 2,4-D to amphibians has not been reported.

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* The classifications for relative toxicity are based on Clarke et al., 1970, where 96-hr LC_{50} values are described as follows: 1 ppm, dangerous or highly toxic, 1-10 ppm, harmful or moderately toxic, and ¶10 ppm, slightly toxic.

2,4-DP

Only a few aquatic toxicity studies are available for 2,4-DP and these are summarized in Table L-38. A 48-hr LC_{50} of 1.1 ppm (isooctyl ester) has been reported for adult bluegill (Pimentel, 1971). This value compares closely with the 96-hr LC_{50} of 1.2 ppm for the butoxyethanol ester of 2,4-D with the same fish species (Table L-37). Because of the close chemical similarities of the two herbicides it is expected that their aquatic toxicities would be similar; in the absence of data on 2,4-DP aquatic toxicity reference values of 2,4-D may be useful in estimating the hazard of 2,4-DP.

Dalapon

Dalapon is slightly toxic to fish based on the results of studies on eggs, fry, fingerlings, and adult fish (Table L-39). Its toxicity to invertebrates is quite variable; some organisms are sensitive such as *Daphnia magna*, brown shrimp, and stonefly nymphs, whereas, dragonflies, snails, and copepods are fairly tolerant. Tadpoles are very tolerant of diuron (96-hr LC_{50} = 4,200 ppm).

Dicamba

Dicamba is only slightly toxic to most aquatic organisms. Dicamba salts and the free acid are considered toxicologically equivalent because the salt hydrolyzes to the free acid in an aqueous environment (EPA, 1983). Short-term LC_{50} values are greater than 10 ppm for fish, amphibia, and most invertebrates (Table L-40). The amphipod *Gammarus lacustris*, with a 96-hr LC_{50} of 3.9 ppm, has shown a greater sensitivity to dicamba than any other aquatic animal tested (Sanders, 1969, in Pimentel, 1977, as cited in USDA, 1984). A 48-hr EC_{50} of 11 ppm was determined for *Daphnia pulex* (Sanders and Cope, 1966, in Hulbert, 1975, as cited in USDA, 1984). *Daphnia magna*, with a 48-hr EC_{50} of greater than 100 ppm (Johnson and Finley, 1980) does not appear to be as sensitive as *D. pulex*. No long-term aquatic toxicity studies have been reported.

Diuron

Diuron is moderately toxic to fish (Table L-41). Ninety-six hour LC_{50}s for technical diuron range from 1.4 ppm for cutthroat trout to 8.2 ppm for bluegill. Aquatic invertebrates are more sensitive to diuron than fish; the lowest LC_{50} is 0.16 ppm for the scud, *Gammarus fasciatus.* Toxicity values for amphibians have not been reported.

Fosamine

Fosamine is considered slightly toxic to nontoxic to fish since all 96-hr LC_{50} values are greater than 100 ppm (Table L-42). Yolk-sac fry, fingerlings, and eggs of salmonids are not acutely sensitive to fosamine. Ninety-six-hour EC_{50}s based on avoidance behavior and white blood cell counts in coho salmon are also greater than 100 ppm. No toxicity information is available for amphibians.

Glyphosate

The aquatic toxicities of the glyphosate formulations Roundup! and Rodeo! are much different, the latter being much less toxic; for this reason they are treated separately in this analysis.

Roundup

Table L-43 summarizes the toxicity of the Roundup! formulation of glyphosate to aquatic organisms. Most 96-hr LC_{50} values range approximately from 2 to 18 ppm, classifying Roundup! as moderately to slightly toxic. The acute toxicity of Roundup! is greater at pH 6.5 than pH 7.5, and toxicity also increases with increasing temperature (Folmar et al., 1979). Rainbow trout did not exhibit avoidance behavior at concentrations up to 10 mg/L, whereas mayfly nymphs showed avoidance behavior at this level (Folmar et al., 1979).

Rainbow trout were exposed for 12 hours to 0.02, 0.2, and 2.0 mg/L of Roundup!. No effects were observed on fecundity or maturation of gonads after being held in freshwater for 30 days (Folmar et al., 1979). Midge larvae were also exposed to 0.02, 0.2 and 2.0 mg/L of Roundup. Significant increases in stream drift of the larvae were observed at the highest concentration (Folmar et al., 1979).

Rodeo

The Rodeo! formulation (53.5 percent isopropylamine salt of the active ingredient N-phosphonomethyl glycine) of glyphosate is practically nontoxic to aquatic organisms. The 96-hr LC_{50}s for fish are all greater than 1,000 ppm, and the 48-hr LC_{50} for Daphnia magna is 930 ppm (Table L-43) (Monsanto, 1983). No long-term aquatic toxicity studies have been reported.

No studies are available on the toxicity of glyphosate to amphibians.

Hexazinone

The aquatic toxicity of hexazinone is summarized in Table L-44. Hexazinone is only slightly toxic to fish; all 96-hr LC_{50}s are greater than 100 ppm. EPA (1982 in USDA, 1984) described technical hexazinone as "practically nontoxic" to fish. It is also only slightly toxic to aquatic invertebrates. No studies have been reported with amphibians.

Picloram

Tordon 101 is moderately to slightly toxic and picloram is generally only slightly toxic to aquatic organisms. All reported LC_{50}s for picloram are greater than 10 ppm (Table L-45).

Aquatic insects and crustaceans have 24-hr LC_{50}s of 50 to 120 ppm for picloram. Daphnia showed no effect during a 24-hour exposure to 380 ppm (USDA, 1984). For lake trout and cutthroat trout technical grade picloram (90 percent a.i.) is more toxic than the other formulations with 96-hr LC_{50}s of 4.25 and 5.0 ppm, respectively.

Some aquatic invertebrates (Gammarus fasciatus and Pteronarcys californica) have also shown a high sensitivity to technical grade picloram (Table L-45). Woodward (1979, in Ghassemi et al., 1981) reported increased fry mortality in cutthroat trout at concentrations of picloram (technical grade) greater than 1,300 ug/l and reduced fry growth above 610 ug/l (flow through tests). No adverse effects to fry occurred at below 290 ug/l. Similar findings have been reported by Scott et al. (1977, in Mullison, 1985). EPA (1985) has also reported chronic studies on lake trout, where low concentrations of picloram adversely affected the rate of yolk sac absorption and growth of fry. Johnson and Finley (1980) have reported a chronic NOEL for lake trout fry of less than 35 ug/l.

No adverse effects on growth were reported for algae, Daphnia, goldfish, and guppies exposed to 1 ppm picloram for 10 weeks. Guppies exhibited no adverse effects at this same concentration after 6 months of exposure (Lynn, 1965, in Ghassemi et al., 1981).

No studies with frog tadpoles or other amphibians have been reported.

Simazine

Simazine is moderately to slightly toxic to fish and aquatic invertebrates (Table L-46). Studies with the fathead minnow indicated a 4 percent granular formulation was much more toxic than the technical material or 80 percent wettable powder. Insects and some microcrustaceans (water fleas and seed shrimp) are more sensitive than the other organisms that have been tested. No toxicity studies with amphibians are available.

Tebuthiuron

The toxicity of tebuthiuron to aquatic organisms is summarized in Table L-47. This herbicide is slightly toxic to fish and invertebrates. Acute toxicity values are greater than 100 ppm for all aquatic species tested with the exception of the pink shrimp (96-hr LC_{50} = 48 ppm). NOELs have been determined, based on early life stage studies, of 26 ppm for rainbow trout, 9.3 ppm for fathead minnow, and 21.8 ppm for Daphnia magna. No studies are available on amphibians.

Triclopyr

The toxicity of triclopyr to aquatic species is summarized in Table L-48. The butoxyethyl ester is highly toxic to fish, whereas the triethylamine salt is only slightly toxic; the 96-hr LC_{50}s for rainbow trout are 0.74 ppm for the butoxyethyl ester and 552 ppm for the triethylamine salt. Unformulated triclopyr is also only slightly toxic. No studies on amphibians are available.

Table L-33
Toxicity of asulam to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Salmon	3,250	48-hr LC_{50}	Bohmont, 1967, in Pimentel, 1971
Bluegill	1,200	24-hr LC_{50}	Lorz et al., 1979, in USDA, 1984
Fathead minnow	>100	96-hr LC_{50}	Mayer and Ellersieck, 1986
Channel catfish	>160	96-hr LC_{50}	Mayer and Ellersieck, 1986
Mosquito fish	2,100 (Amitrol-T)	96-hr LC_{50}	Johnson, 1978, in USDA, 1984
Emerald Shiner	455 (Cytrol Amitrol-T)	24-hr LC_{50}	In USDA, 1984
Crayfish *Orconectes*	>100 (Amitrol-T)	48-hr LC_{50}	Sanders, 1979, in USDA, 1984
Brine shrimp	5	Reduced zygote production at 31-41 days	Grosch, 1980, in USDA, 1984
Water flea *Daphnia magna*	1.43 23	96-hr LC_{50} 26-hr EC_{50} (based on immobilization)	In USDA, 1984
Copepod *Cyclops vernalis* - nauplii larvae	22.1 (18.5-27.7)	96-hr LC_{50}	In USDA, 1984
Aquatic sowbug *Asellus* sp.	>100 (Cytrol Amitrol-T)	96-hr LC_{50}	Johnson and Finley, 1980
Tadpole *Adelotus brevis*	3,000 (Weedazol TL plus)	96-hr LC_{50}	Johnson, 1976, in USDA, 1984

Table L-34
Toxicity of asulam to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Rainbow trout	>5,000	96-hr LC_{50}	WSSA, 1983
Bluegill	>3,000	96-hr LC_{50}	WSSA, 1983
Channel catfish	>5,000	96-hr LC_{50}	WSSA, 1983
Goldfish	>5,000	96-hr LC_{50}	WSSA, 1983
Harlequin fish	>1,700	96-hr LC_{50}	WSSA, 1983

Table L-35
Toxicity of atrazine to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Rainbow trout	24 (18-32) (atrazine 4 L)	96-hr LC_{50} (95% C.L.)	Mayer and Ellersieck, 1986
	4.5 (3.5 -5.7) (technical)	96-hr LC_{50}	Bathe et al., 1976 in USDA, 1984
- fry	0.87 (0.63-1.15)	96-hr LC_{50} Teratogenic effects in 3, 6, and 62% at 0.05, 0.54, and 5.02 ppm respectively. Exposure from spawning to 96 hours post hatching.	Birge et al., 1979 and 1983 in USDA, 1984
Brook trout	6.3 (4.1-9.7)	96-hr LC_{50}	Macek et al., 1976 in USDA, 1984
- fry	0.24	Reduced survival and growth.	Macek et al., 1976 in USDA, 1984
- adults	0.72	No effect on survival, egg production, or egg hatching.	Macek et al., 1976 in USDA, 1984
Bluegill	42 (36 - 39) (atrazine 4 L)	96-hr LC_{50} (95% C.L.)	Mayer and Ellersieck, 1986
	0.5	Fish became lethargic, fed poorly, and had partial loss of equilibrium after 28 days.	Macek et al., 1976 in USDA, 1984
	6 (approx.) (wettable powder)	96-hr LC_{50}	In USDA, 1984
- eggs & fry	0.095	No effects on hatching, survival, or growth after 18 months.	Macek et al., 1976 in USDA, 1984

Table L-35 (Cont.)

Species	Concentration (ppm)	Effect	Source
Fathead minnow	15 (11-20)	96-hr LC_{50}	Macek et al., 1976 in USDA, 1984
- fry	0.52	25% mortality at 96 hours.	
	0.213	No effect on survival, growth, or spawning after 43 weeks.	
Catfish	7.6 (atrazine)	96-hr LC_{50}	In USDA, 1984
	35 (80% wettable powder)	96-hr LC_{50}	In USDA, 1984
	0.22 (0.15-0.32)	96-hr LC_{50} Teratogenic effects in 4, 13, 69, and 100% at 0.06, 0.43, 4.83, and 46.7 ppm respectively. Exposure from spawning to 96 hours post hatching.	Birge et al., 1979 and 1983 in USDA, 1984
Brown shrimp	1.0	30% mortality or immobility at 48 hours.	Butler, 1965 in USDA, 1984
Water fleas	3.6	48-hr LC_{50}	In USDA, 1984
Daphnia magna	1.15	Decreased fecundity, no effect on survival.	Macek et al., 1976 in USDA, 1984
D. pulex	1.0	Decreased fecundity. Decreased survival at 20 ppm, not at 10. Synergistic effects with ethanol.	Schaber and Lambert in USDA, 1984

Table L-35 (Cont.)

Species	Concentration (ppm)	Effect	Source
Scud *Gammarus fasciatus*	5.7 (3.6-8.0)	48-hr LC_{50}	Macek et al., 1976 in USDA, 1984
	0.14	Reproductive effects and reduced survival of offspring at exposures of 30 days to 17 weeks.	
Clams and snails	0.5	87.5% mortality in clams; snails increased by approximately 400%.	In USDA, 1984
Midge *Chironomus tentans* - larvae	0.72 (0.36 - 1.44)	48-hr LC_{50}	Macek et al., 1976 in USDA, 1984
	0.11	No adverse effect after 2 generations; reduced hatching success, increased larval mortality, and retarded development at 0.23 ppm.	
Bullfrog -tadpoles	0.41	LC_{50} from spawning to 96 hours post hatching; teratogenic effects of 3, 7, 22, 47, and 100% at 0.4, 6.33, 14.8, 26.4, and 45.8 ppm respectively.	Birge et al., 1980 and 1983 in USDA, 1984
Leopard frog - tadpoles	0.31	Significant decrease in growth from 27-54 days. Significant increase in mortality at 0.31 to 12 ppm from 27 to 54 days of exposure.	Hine et al., 1981 in USDA, 1984

Table L-36
Toxicity of bromacil to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Rainbow trout	75	48-hr LC_{50}	Sherman and Kaplan, 1975
Bluegill	71	48-hr LC_{50}	Sherman and Kaplan, 1975
Carp	164	48-hr LC_{50}	Sherman and Kaplan, 1975
Crayfish	40	72-hr LC_{50}	EPA, 1975
Water flea	40	3-hr LC_{50}	EPA, 1975
Tadpole	230	48-hr LC_{50}	EPA, 1975

Table L-37
Toxicity of 2,4-D butoxyethanol ester to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Rainbow trout			
-fingerlings	1.42 to 1.55	96-hr LC_{50}	Halter, 1980
-yearlings	9.0	96-hr LC_{50}	Dodson and Mayfield, 1979[a]
Bluegill	1.2	96-hr LC_{50}	Johnson and Finley, 1980
Fathead minnow	3.3	96-hr LC_{50}	Johnson and Finley, 1980
Black bullhead	7.1 to 7.7	96-hr LC_{50}	Halter, 1980
Crayfish			
Orconectes nais	> 100	48-hr LC_{50}	Sanders, 1970
Glass Shrimp			
Palaemonetes kadiakensis	1.4	48-hr LC_{50}	Sanders, 1970
Shrimp	1.0	48-hrs, no effect	Ghassemi et al., 1981
Water fleas			
Daphnia pulex	3.0	8 days, no effects	Sigmon, 1979[a]
D. magna	5.6	48-hr LC_{50}	Sanders, 1970
Copepod			
Nitocra spinipes	3.1	96-hr LC_{50}	Linden et al., 1979[a]
Scuds			
Gammarus lacustris	0.44	96-hr LC_{50}	Sanders, 1969[a]
Gammarus fasciatus	5.9	96-hr LC_{50}	Sanders, 1970
Sowbug-			
Asellus brevicaudis	2.6	96-hr LC_{50}	Johnson and Finley, 1980
Seed Shrimp			
Cypridopsis vidua	2.2	48-hr EC_{50}	Johnson and Finley, 1980
	1.8	48-hr LC_{50}	Sanders, 1970

Table L-37 (Cont.)

Species	Concentration (ppm)	Effect	Source
Stonefly *Pteronarcys californica*			
-adult	> 1,000	96-hr LC_{50}	FWPCA, 1968[a]
-nymphs	1.6	96-hr LC_{50}	Sanders and Cope, 1968[a]
Eastern Oyster *Crassostrea virginica*	3.75	96-hr EC_{50}, decrease in shell growth.	Butler, 1965, in USDA, 1984
Snail *Lymnea* sp.	0.32	6 wks LC42	Halter, 1980

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[a] As cited in DEA, 1986

Table L-38
Toxicity of 2,4-DP to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Bluegill			
-adult	1.1[b]	48-hr LC_{50}	Pimentel, 1971[a]
-fry	10[b]	No deaths after 10 days.	Hiltibran, 1967[a]
-juveniles	20[b]	No deaths after 12 days.	Hiltibran, 1967[a]
Lake Chubsucker			
-fry	1.5[b]	No deaths after 10 days.	Hiltibran, 1967[a]

[a] As cited in USDA, 1984.

[b] Granular 2,4-DP-isooctyl ester.

Table L-39
Toxicity of dalapon to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Rainbow trout	340 (sodium salt, powder 74% a.i.)	96-hr LC_{50}	Folmar, 1976, in USDA, 1984
	1.0	avoidance behavior	
Bluegill	105 (technical)	96-hr LD_{50}	Mayer and Ellersieck, 1986
	440 (Radapon!, sodium salt)	96-hr LC_{50}	In USDA, 1984
- fingerlings	> 1,000 (Granular and Wettable Powder)	48-hr LC_{50}	In USDA, 1984
Green Sunfish - fry - eggs	> 50 > 50	8-day LC_{50} 3-day LC_{50}	Hiltibran, 1967, in USDA, 1984
Fathead minnow	290-390 Radapon!, sodium salt)	96-hr LC_{50} (toxicity greater in soft water vs. hard water)	In USDA, 1984
Channel catfish - fingerlings	10	Less than 10% mortality at 48 hrs.	McCorkle et al., 1977,in USDA, 1984
Smallmouth bass - fry	> 50	8-day LC_{50}	Hiltibran, 1967, in USDA, 1984
Mosquito fish	> 19,100	96-hr LC_{50}	Johnson, 1978, in USDA, 1984
Grass carp	> 30,000 (Dalapon 85% a.i.)	96-hr LC_{50} (No mortality observed)	Tooby et al., 1980, in USDA, 1984
Emerald shiner	> 3,000	72-hr LC_{50} (no toxic effects)	Springer, 1957 in Pimentel, 1971
Lake chubsucker - fry	> 50	8-day LC_{50}	Hiltibran, 1967, in USDA, 1984
Brown shrimp	1.0 (sodium salt Radapon)	48-hr EC_{50} 40% mortality or immobilization	Butler, 1965, in USDA, 1984

Table L-39 (Cont.)

Species	Concentration (ppm)	Effect	Source
Water fleas			
Daphnia magna	6	48-hr LC_{50}	FWPCA, 1968, in Pimentel, 1971
Daphnia pulex	11 (8.2 - 14.7)	48-hr LC_{50}	Mayer and Ellersieck, 1986
Simocephalus serrulatus	16 (11.4 - 22.4)	48-hr EC_{50}	Mayer and Ellersieck, 1986
Copepods			
Cyclops sp.	400 (sodium salt)	100% mortality at 24 hrs; no mortality at 200 ppm.	Kenaga, 1974, in USDA, 1984
Nitocra spinipes	4,800 (sodium salt, Nacam)	96-hr LC_{50}	Linden et al., 1979, in USDA, 1984
Fairy shrimp			
Eubranchipus sp.	400 (sodium salt)	100% mortality at 24 hrs; no mortality at 200 ppm.	Kenaga, 1974, in USDA, 1984
Stonefly			
Pteronarcys sp. - nymphs	1.0 (sodium salt)	24-hr LC_{50}	Cope 1965, in Pimentel, 1971,
Pteronarcys californica	> 1,000	96-hr LC_{50}	Mayer and Ellersieck, 1986
Dragonfly			
Aeschna sp.	> 1,600 (sodium salt a.e.)	No mortalities at 48 hours.	Kenaga, 1974, in USDA, 1984
Snails			
Planorbis sp.	400 (sodium salt a.e.)	50% mortality; no mortality at 200 ppm.	Kenaga, 1974, in USDA, 1984
Physa sp.	400 (sodium salt a.e.)	50% mortality; no mortality at 200 ppm.	Kenaga, 1974, in USDA, 1984
Tadpoles			
Adelotus brevis	4,200 (Dowpon!)	96-hr LC_{50}	Johnson, 1976, in USDA, 1984

Table L-40
Toxicity of dicamba (88% technical) to aquatic organisms

Species	96-hour LC$_{50}$ (ppm)	Source
Rainbow trout		
-fingerlings, 0.8g	28	Johnson and Finley, 1980
	135	Velsicol Chem. Corp. in Ghassemi et al., 1981
Cutthroat trout	> 50	Woodward, 1982, in USDA, 1984
Coho Salmon		
-juveniles	120^a	Lorz et al., 1979, in USDA, 1984
Bluegill		
-fingerlings, 0.9g	> 50	Johnson and Finley, 1980
	135	Velsicol Chem. Corp. in Ghassemi et al., 1981
Glass Shrimp *Palaemonetes kadiakensis*	> 56	Johnson and Finley, 1980
Water flea		
Daphnia sp.	11^b	Sanders and Cape, 1966, in Hurlbert, 1975, in USDA, 1984
Daphnia magna -1st instar	> 100^b	Mayer and Ellersieck, 1986
Scud *Gammarus fasciatus*	> 100	Johnson and Finley, 1980
Sowbug *Asellus brevicaudus*	> 100	Johnson and Finley, 1980
Frog, tadpole		
-(1-2 wks old) *Adelotus brevis*	185	Johnson, 1976, in USDA, 1984
-(1-2 wks old) *Limnodynastes peroni*	106	Johnson, 1976, in USDA, 1984

[a] 48-hr LC$_{50}$

[b] 48-hr EC$_{50}$

Table L-41
Toxicity of diuron to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Rainbow trout	4.9 (4.1 - 5.9)[a]	96-hr LC_{50} (95% C.L.)	Johnson and Finley, 1980
	16 (11-23)[b]	96-hr LC_{50} (95% C.L.)	
Lake trout	2.7 (2.4 - 3.0)[a]	96-hr LC_{50} (95% C.L.)	Johnson and Finley, 1980
Cutthroat trout	1.4 (1.1 - 1.9)[a]	96-hr LC_{50} (95% C.L.)	Johnson and Finley, 1980
Bluegill	8.2 (7.4 - 9.1)[a]	96-hr LC_{50} (95% C.L.)	Johnson and Finley, 1980
Water fleas			
Daphnia pulex	1.4 (1.0 - 1.9)[a]	48-hr EC_{50} (95% C.L.)	Johnson and Finley, 1980
Simocephalus serrulatus	2.0 (1.4 - 2.8)[a]	48-hr EC_{50} (95% C.L.)	Johnson and Finley, 1980
Scud *Gammarus fasciatus*	0.16 (0.13 - 0.19)[a]	96-hr LC_{50} (95% C.L.)	Johnson and Finley, 1980
Sowbug *Asellus brevicaudus*	15.5 (7.2-33.4)[a]	96-hr LC_{50} (95% C.L.)	Johnson and Finley, 1980
Stonefly *Pteronarcys californica*	1.2 (0.9 - 1.7) [a]	96-hr LC_{50} (95% C.L.)	Johnson and Finley, 1980

[a] Technical material, 95%

[b] Wettable powder, 80%

Table L-42
Toxicity of fosamine to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Rainbow trout -adult	> 100	96-hr LC_{50}	Mayer and Ellersieck, 1986
-adult	> 1,000[a]	96-hr LC_{50} (No effects at 1,000 ppm)	Schneider and Kaplan, 1983, in USDA, 1984
-yolk-sac fry (alevin)	367[b]	96-hr LC_{50}	USDA, 1984
-eggs	1,456[b]	lowest 96-hr LC_{50}	
Coho salmon	8,290[a]	96-hr LC_{50}	Schneider and Kaplan, 1983, in USDA, 1984
	295[a]	96-hr EC_{50}, based on avoidance behavior; threshold at 8.9 ppm	
	198[a]	96-hr EC_{50}, acute stress based on leucocrit values; threshold at 4 ppm	
-egg stages	25,377	lowest 96-hr LC_{50}	USDA, 1984
-yolk sac fry (alevin)	618[b]	96-hr LC_{50}	
-fingerlings	2,669	lowest 96-hr LC_{50}	
-yearling	3,295	lowest 96-hr LC_{50}	
Bluegill	670 (378-1,190)[a]	96-hr LC_{50} (95% C.L.)	Schneider and Kaplan, 1983, in USDA, 1984
Fathead minnow	> 1,000[a]	96-hr LC_{50} (No effects at 1,000 ppm)	Schneider and Kaplan, 1983, in USDA, 1984

Table L-42 (Cont.)

Species	Concentration (ppm)	Effect	Source
Channel catfish	> 100	96-hr LC_{50}	Mayer and Ellersieck, 1986
Water flea *Daphnia magna*	1,524 (1,310-1,720)[a]	48-hr LC_{50} (95% C.L.)	Schneider and Kaplan, 1983, in USDA, 1984
Scud *Gammarus pseudolimnaeus*	> 100	96-hr LC_{50}	Mayer and Ellersieck, 1986
Midge *Chironomus plumosus*	> 100	48-hr LC_{50}	Mayer and Ellersieck, 1986

[a] ammonium salt

[b] Krenite!

Table L-43
Acute toxicity of glyphosate to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Roundup!:			
Rainbow trout			
-fingerlings, 1g	1.3	96-hr LC_{50}	Folmar, 1979
-fingerlings, 2g	7.4 to 14.	96-hr LC_{50}	
Bluegill	1.8 to 4.2	96-hr LC_{50}	Folmar, 1979
Fathead minnow	2.3	96-hr LC_{50}	Folmar, 1979
Channel Catfish			
-fingerlings	13.	96-hr LC_{50}	Folmar, 1979
-swim-up fry	3.3	96-hr LC_{50}	
-adult	16.	96-hr LC_{50}	Monsanto, 1982
Grass carp	15.	96-hr LC_{50}	Tooby et al., 1980
Carp	3.9	96-hr TL_{50}	Monsanto, 1982
Crayfish	> 1,000	96-hr LC_{50}	Monsanto, 1982
Water flea *Daphnia magna*	3.0	48-hr LC_{50}	Folmar, 1979
Copepod *Nitocra spinipes*	22.	96-hr LC_{50}	Linden et al.,1979
Scud *Gammarus pseudolimnaeus*	43.	96-hr LC_{50}	Folmar, 1979
Midge larvae	18.	48-hr EC_{50}	Folmar, 1979
Rodeo!:			
Trout	> 1,000	96-hr LC_{50}	Monsanto, 1983
Bluegill	> 1,000	96-hr LC_{50}	Monsanto, 1983
Carp	> 10,000	96-hr LC_{50}	Monsanto, 1983
Water flea *Daphnia magna*	930	48-hr LC_{50}	Monsanto, 1983

Table L-43 (Cont.)

Species	Concentration (ppm)	Effect	Source
Glyphosate[b]:			
Rainbow Trout	140 (120-170)	96-hr LC_{50}	Folmar et al., 1977[a]
	38	96-hr LC_{50}	USDA, 1981[c]
Bluegill	140 (110-160)	96-hr LC_{50} (static test)	Folmar et al., 1977[a]
	24	96-hr LC_{50} (flow through test)	USDA, 1981[c]
Fathead minnow	97 (79-120)	96-hr LC_{50}	Folmar et al., 1977[a]
Channel catfish	130 (110-160)	96-hr LC_{50}	Folmar et al., 1977[a]
Carp	115	96-hr LC_{50}	USDA, 1981[c]
Water flea Daphnia sp.	780	40-hr LC_{50}	Monsanto Company, 1982[c]
Midge Chironomus plumosus	55	48-hr EC_{50}	Folmar et al., 1979[c]

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[a] In Ghassemi et al., 1981

[b] Technical glyphosate (95% or more of active ingredient) is assumed to be the formulation used.

[c] In USDA, 1984

Table L-44
Toxicity of hexazinone to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Rainbow trout	320-420[b]	96-hr LC_{50}	EPA, 1982[a]; Technical Data Sheet for Hexazinone, Du Pont
	>180[c]	96-hr LC_{50}	Mayer and Ellersieck, 1986
Brook trout	>100[b,c]	96-hr LC_{50}	Mayer and Ellersieck, 1986
Bluegill	505 (450-538)	96-hr LC_{50} (95% C.L.)	EPA, 1982[a]
	370-420	96-hr LC_{50}	EPA, 1982[a]
	925 (782-1,049)[d]	96-hr LC_{50} (95% C.L.)	Schneider and Kaplan, 1983[a]
Fathead minnow	274 (207-361)[b]	96-hr LC_{50} (95% C.L.)	EPA, 1982[a]; Technical Data Sheet for Hexazinone, Du Pont
Fiddler crab	>1,000[b]	96-hr LC_{50}	EPA, 1982[a]
Grass shrimp	56-100[b]	96-hr LC_{50}	EPA, 1982[a]
Water flea *Daphnia magna*	151.6 (125.2-172.8)[b]	48-hr LC_{50} (95% C.L.)	EPA, 1982[a]
Daphnia sp.	20-50[b] 10[b]	21-day LC_{50} 21-day NOEL	Mayack et al., 1982[a] and EPA, 1982[a]
Eastern oyster -larvae	320-560[b]	48-hr EC_{50}, based on reduction in number of normal embryos.	EPA, 1982[a]

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[a] As cited in USDA, 1984

[b] Technical

[c] 90% wettable powder

[d] Velpar! L - 25% hexazinone liquid

Table L-45
Toxicity of picloram to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Tordon 101! (10.2% picloram-TIPA[c], 5.7% a.e., and 21.2% a.e. 2,4-D TIPA):			
Rainbow trout	8.6 a.e. Tordon 31.8 a.e. 2,4-D	96-hr LC_{50}	Lynn, 1965, and Winston, 1963, in Kenaga, 1969
Brook trout	13.7 a.e. Tordon 50.9 a.e. 2,4-D	96-hr LC_{50}	Lynn, 1965, and Winston, 1963, in Kenaga, 1969
Brown trout	13.1 a.e. Tordon 48.8 a.e. 2,4-D	96-hr LC_{50}	Lynn, 1965, and Winston, 1963, in Kenaga, 1969
Coho salmon	17.5	24-hr LC_{50}	Spehar et al., 1981[a]
Green sunfish	8.6 a.e. Tordon 31.8 a.e. 2,4-D	96-hr LC_{50}	In Kenaga, 1969
Fathead minnow	3.7 a.e. Tordon 13.7 a.e. 2,4-D	96-hr LC_{50}	Lynn, 1965, and Winston, 1963, in Kenaga, 1969
Pugnose minnow	7.6 a.e. Tordon 28.2 a.e. 2,4-D	96-hr LC_{50}	In Kenaga, 1969
Goldfish	4.3 a.e. Tordon 15.9 a.e. 2,4-D	24-hr LC_{50}	Hardy, 1963, in Kenaga, 1969
Water flea *Daphnia* sp.	530	95% mortality at 24 hrs; no mortality at 380 ppm	Lynn, 1965
Snail	530	100% mortality at 72 hrs.; no mortality at 380 ppm	Lynn, 1965

Table L-45 (Cont.)

Species	Concentration (ppm)	Effect	Source
Picloram:			
Rainbow trout	24 - 34 (a.e.[b])	24 to 96 hr LC_{50}	U.S. DOI, 1965, in Kenaga, 1969
Coho salmon	21 - 29 (a.e.)	96-hr LC_{50}	Bond et al., 1967, in Kenaga, 1969
Bluegill	21 - 26.5 (a.e.)	96-hr LC_{50}	Bond et al., 1967, in Kenaga, 1969
Largemouth bass	13.1 - 19.7 (a.e.)	24 to 48-hr LC_{50}	U.S. DOI, 1964, in Kenaga, 1969
Goldfish	14 - 36	24 to 96-hr LC_{50}	U.S. DOI, 1964, in Kenaga 1969
Mosquito fish	120 - 133 (a.e.)	24 to 96-hr LC_{50}	Johnson, 1978[a]
Brown shrimp	1	48-hr NOEL	U.S. DOI, 1966[a]
Water flea *Daphnia sp.*	530	95 percent mortality at 24 hours, NOEL at 380 ppm.	Lynn, 1965[a]
	1	No observed effect on growth and reproduction after 10 weeks.	Hardy, 1966[a]
Scud *Gammarus lacustris*	50	24-hr LC_{50}	Sanders, 1969[a]
	48	48-hr LC_{50}	U.S. DOI, 1968, in Pimentel, 1971[a]
Stonefly nymphs, *Pteronarcys californica*	120	24-hr LC_{50}	Sanders and Cope, 1968[a]
Eastern oyster	1	No observed effect on shell growth after 48 hours.	Butler, 1965[a]

Table P-45 (Cont.)

Species	Concentration (ppm)	Effect	Source
Technical Grade (90% a.i.):			
Rainbow trout	12.5	96-hr LC_{50}	Johnson and Finley, 1980
Lake trout	4.25	96-hr LC_{50}	Woodward, 1976[a]
	0.035	Decreased rate of yolk sac absorption and growth in fry, chronic exposure.	Johnson and Finley, 1980
Cutthroat trout	5.0	96-hr LC_{50}	Woodward, 1976[a]
	> 1.3	After 22 days exposure increased fry mortality;	Woodward, 1979[a], in USDA, 1984 and in Ghassemi et al., 1981
	> 0.610	reduced growth of fry;	
	> 0.29	no adverse effects	
Bluegill	23.0	96-hr LC_{50}	Johnson and Finley, 1980
Channel catfish	6.3 - 15.5	96-hr LC_{50}	Johnson and Finley, 1980
Scud *Gammarus fasciatus*	0.027	96-hr LC_{50}	Johnson and Finley, 1980
Stoneflies *Pteronarcella badia*	> 10.0	96-hr LC_{50}	Johnson and Finley, 1980
Pteronarcys californica	0.048	96-hr LC_{50}	Johnson and Finley, 1980

[a] As cited in USDA, 1984

[b] a.e. - acid equivalent

[c] TIPA-triisopropylamine salt

Table L-46
Toxicity of simazine to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Rainbow trout	>100 (technical)	96-hr LC_{50}	Mayer and Ellersieck, 1986
	2.5 (dissolved in 0.1% acetone)	No effects after 28 days exposure and 56 days of observation	Bathe et al., 1975 in USDA, 1984
	2.8	96-hr LC_{50}	In Mauck, 1974 in USDA, 1984
Bluegill	100 (90.9 - 110) (80% wettable powder)	96-hr LC_{50} (95% C.L.)	Mayer and Ellersieck, 1986
	11.6	96-hr LC_{50}	In Mauck, 1974 in USDA, 1984
	36 (simazine 80W)	96-hr LC_{50}	In Mauck, 1974 in USDA, 1984
Fathead minnow	>10 (technical)	96-hr LC_{50}	Mayer and Ellersieck, 1986
	510 (373 - 698) (80% wettable powder)	96-hr LC_{50}	
	5 (3.5 - 7.15) (4% granular)	96-hr LC_{50}	
Channel catfish	85 (simazine 80W)	96-hr LC_{50}	In Mauck, 1974 in USDA, 1984
Pumpkinseed	28 (simazine 80W)	96-hr LC_{50}	In Mauck, 1974 in USDA, 1984
Redear sunfish	55 (simazine 80W)	96-hr LC_{50}	In Mauck, 1974 in USDA, 1984
Largemouth bass	25-45 (simazine 80W)	96-hr LC_{50}	In Mauck, 1974 in USDA, 1984
Yellow perch	100 (simazine 80W)	96-hr LC_{50}	In Mauck, 1974 in USDA, 1984

Table L-46 (Cont.)

Species	Concentration (ppm)	Effect	Source
Bluntnose minnow	63 (simazine 80W)	96-hr LC_{50}	In Mauck, 1974 in USDA, 1984
Scud *Gammarus fasciatus*	130 (technical)	96-hr LC_{50}	Mayer and Ellersieck, 1986
G. lacustris	13	96-hr LC_{50}	In USDA, 1984
Seed shrimp *Cypridopsis vidua*	3.7(2.6 - 5.3)	48-hr LC_{50}	Mayer and Ellersieck, 1986
Glass shrimp *Palaemonetes*	>5.6	24-hr LC_{50}	Mayer and Ellersieck, 1986
Stonefly *Pteronarcys californica*	1.9 (0.9 - 4.0) (technical)	96-hr LC_{50}	Mayer and Ellersieck, 1986
Water flea *Daphnia magna*	1.1 (0.56 - 2.2) (technical)	48-hr EC_{50}	Johnson and Finley, 1980
Sowbug *Asellus brevicaudus*	>100 (technical)	48-hr LC_{50}	Sanders, 1970 in USDA, 1984
Crayfish *Orconectes nais*	>100	48-hr LC_{50}	Sanders, 1970 in USDA, 1984

Table L-47
Toxicity of tebuthiuron to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Rainbow trout	144	96-hr LC_{50}	In USDA, 1984
- eggs & larvae	26	NOEL, no effects on hatchability, growth, behavior, development, or survival; reduced growth and survival at 52 ppm.	In USDA, 1984
Bluegill	112	96-hr LC_{50}	In USDA, 1984
Fathead minnow	>160 (technical)	96-hr LC_{50}	Todd et al., 1974, in USDA 1984
- eggs & larvae	9.3	NOEL, no effects on hatching, growth, development, behavior, or survival; reduced growth at 18 ppm.	In USDA, 1984
Goldfish	>160	96-hr LC_{50},	Todd et al., 1974, in USDA, 1984
Fiddler crab	>320	96-hr LC_{50}, 320 ppm was highest concentration tested.	In USDA, 1984
Pink shrimp	48	96-hr LC_{50}	In USDA, 1984
Water flea *Daphnia magna*	297	48-hr EC_{50}	In USDA, 1984
	21.8	No effects on reproduction, growth, or survival with lifetime exposure.	In USDA, 1984
Oyster - embryos	180-320	48-hr EC_{50}, abnormal development.	In USDA, 1984

Table L-48
Toxicity of triclopyr to aquatic organisms

Species	Concentration (ppm)	Effect	Source
Rainbow trout	0.74[a]	96-hr LC_{50}	Dow Chemical Company, 1983, in USDA, 1984
	552[b]	96-hr LC_{50}	
	117	96-hr LC_{50}	
Bluegill	0.87[a]	96-hr LC_{50}	Dow Chemical Company, 1983, in USDA 1984
	891[b]	96-hr LC_{50}	
	148 (triclopyr)	96-hr LC_{50}	
Fathead minnow	120 to 245[b,c]	96-hr LC_{50} Toxicity increased with temperature between 17 - 26°C.	Mayes et al. (in press), in USDA, 1984
	101 (88.5 - 116)[b,c]	8-day LC_{50} 24.8 - 25.8°C.	
- embryo-larval stages	114[b,c]	98% mortality at 28 days; 21% mortality in controls.	
Crab	>1,000[d]	96-hr LC_{50}	Dow Chemical Company, 1983, in USDA, 1984
Shrimp	895[d]	96-hr LC_{50}	Dow Chemical Company 1983, in USDA, 1984
Water flea Daphnia magna	1,170 (1,030 - 1,340)[b]	48-hr LC_{50} (95% C.L.)	Gersich et al., 1984
	1,140 (950 - 1,590)[b]	21-day LC_{50}	
	110	MATC based on total young and brood size.	
Oyster	56 - 87[d]	48-hr LC_{50}	Dow Chemical Company 1983, in USDA, 1984

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[a] Garlon! 3A butoxyethyl ester
[b] Garlon! 3A-triethylamine salt (TEA) or other TEA formulation
[c] Flow-through tests
[d] Garlon! 3A-type not specified

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GLOSSARY

ADSORPTION: Adhesion of substances to the surfaces of solids or liquids; technically, the attraction of ions of compounds to the surfaces of solids or liquids.

ADVANCING HEADCUT: An erosional process in which the vertical erosion face (headcut) moves upslope or up a drainage.

ALLOWABLE CUT: The amount of timber that may be harvested annually or periodically from a specified area over a stated period in accordance with the objectives of management.

ALLELOPATHIC: Pertaining to the suppression of growth of one plant species by another through the release of toxic substances.

ALLUVIAL DEPOSITS: Deposits of sand, gravels, and cobbles resulting from the reduction in carrying capacity of flowing water. As flowing water slows, its carrying capacity drops, allowing material to settle out.

AMINE: Any of a group of chemical substances formed by exchanging one, two, or three hydrogen atoms for one, two, or three hydrocarbon groups.

ANIMAL UNIT MONTH (AUM): The amount of forage needed to sustain one cow and a calf (6 months old or younger) or their equivalent for 1 month.

ANNUAL PLANT: A plant that completes its life cycle within a year.

AREA OF CRITICAL ENVIRONMENTAL CONCERN (ACEC): An area within the public lands where special management attention is required (when such areas are developed or used, or where no development is required) to protect and prevent irreparable damage to important historic, cultural, or scenic values; fish and wildlife resources; or other natural systems or processes; or to protect life and safety from natural hazards.

AUTHORIZED OFFICER: A designated Federal regulatory agency employee responsible for activities involving the use of public lands or delegated to exercise authority over grants for use of these lands.

BATHOLITH: A great mass of intruded igneous rock that for the most part stopped in its rise a great distance below the surface.

BEST MANAGEMENT PRACTICE: A practice or combination of practices that is determined after problem assessment, examination of alternative practices and public participation to be the most effective, practicable means of preventing or reducing the amount of pollution generated by non-point source to a level compatible with water quality goals.

BETA CAMERA ANALYSIS: A method of analyzing movement of a radioactive isotope by recording on film the emittance of beta rays over a time interval.

BIENNIAL PLANT: A plant that completes its life cycle in 2 years.

BIOACCUMULATION: The accumulation of a substance in an ecoysystem. A chemical that does not bioaccumulate, decomposes rapidly in the environment.

BIOASSAY: The testing of the effects of chemical substances on live organisms under controlled conditions.

BIOLOGICAL CONTROL: The use of natural enemies to attack a target plant, retard growth, prevent regrowth, or prevent seed formation.

BOARD FOOT: A unit of solid wood, 1 foot square and 1 inch thick.

BOOM (HERBICIDE SPRAY): A tubular metal device that conducts a herbicide mixture from a tank to a series of spray nozzles. A boom may be mounted beneath an aircraft or behind a tractor.

BROADCAST APPLICATION: The applying of pesticide over an entire area or field rather than only to rows, beds, or individual plants. See SPOT TREATMENT.

BROADCAST BURNING: International burning in which fire is intended to spread over all of a specific area. It may or may not qualify as prescribed burning.

BROWSE: That part of leaf and twig growth of shrubs, woody vines, and trees on which browsing animals can feed; to consume browse.

BUFFER (STRIP OR ZONE): A zone left untreated with herbicide (at the outer edge of a treated area or along streams) as protection against the effects of treatment.

CARBON 14 DATING: A method of dating archaeological and geological materials through the measurement of carbon 14--a heavy isotope of carbon of mass number 14.

CARCINOGENIC: A substance producing or inciting cancer.

CATEGORICAL EXCLUSION: A category of actions that do not individually or cumulatively have significant effects on the human environment and for which neither an environmental assessment nor an environmental impact statement is required.

CATEGORY A PLANT: A State of California rating of noxious weeds which requires eradication, quarantine regulation, containment, rejection, or other holding action at the state-county level. Quarantine interceptions to be rejected or treated at any point in the state.

CATEGORY B PLANT: A State of California rating of noxious weeds which calls for eradication, containment, control, or other holding action at the discretion of the agricultural commissioner.

CHAPARRAL: A brush community composed of evergreen sclerophyllous (hard waxy coated leaves) species.

CHEMICAL DEGRADATION: The breakdown of a chemical substance into simpler components through chemical reactions.

CLEARCUTTING: A method of timber harvesting in which all trees (merchantable or unmerchantable) are cut from an area.

COLLOID: See SOIL COLLOID.

COMMERCIAL FOREST LAND: Forest land that is now producing or is capable of producing at least 20 cubic feet per acre per year of commercial coniferous tree species.

CONIFER RELEASE: Any action taken on an established commercial timber stand to control stand composition and promote dominance and/or growth of suitable tree species. Treatments may include mechanical or manual slashing of undesirable brush and tree species, herbicides, biological control or a combination of methods. Forest fertilization is not considered a release treatment.

CONTACT SYSTEMIC HERBICIDE: A herbicide applied directly to a plant, which is absorbed in its leaves and then translocated throughout the plant.

CONTROL: Reduction of a pest problem to a point where it causes no significant economic damage.

CREEPING PERENNIALS: Perennial plants that spread by means of specialized modified aboveground stems (stolons) or belowground stems (rhizomes) as well as by seeds. Because of their method of spread, creeping perennial noxious weeds are the most difficult to control.

CRITICAL HABITAT: (1) Specific areas within the habitat occupied by a species at the time it is listed under the Endangered Species Act where there are physical or biological features (i) essential to the conservation of the species and (ii) that may require special management considerations or protection, and (2) specific areas outside the habitat occupied by the species at the time it is listed upon the determination by the Secretary of the Interior that such areas are essential for the conservation of the species.

CRUCIAL WILDLIFE HABITAT: An area of habitat essential to the survival of any wildlife species sometime during its life cycle.

CULTURAL RESOURCES: Remains of human activity, occupation, or endeavor, reflected in districts, sites, structures, building, objects, artifacts, ruins, works of art, architecture, and natural features that were of importance in past human events. Cultural resources consist of (1) physical remains, (2) areas where significant human events occurred, even though evidence of the events no longer remains, and (3) the environment immediately surrounding the actual resource.

DENSITY: Relative closeness of individual plants to one another. Number of individuals per unit area.

DERMATITIS: Inflammation of the skin.

DNA (DEOXYRIBONUCLEIC ACID): Any of the nucleic acids that are the molecular basis of heredity in many organisms.

DOSAGE: The regulation of doses: how often and for how long.

DOSE: The amount of chemical administered at one time.

DRIFT: The movement of airborne herbicide particles by air motion or wind away from an intended target area.

DRIP TORCH: A container of slash-burning fuel equipped with a wick to ignite the fuel mixture as it drips from the container onto the slash. Hand-held torches have a 1.5-gallon capacity and are ignited by a fiber-filled, fuel-soaked wick.

ECOLOGICAL CONDITION: The current productivity of a site relative to the naturally capable production.

ECOLOGICAL NICHE: The physical space in a habitat occupied by an organism; its functional role in a community; and its position in environmental gradients of temperature, moisture, pH, soil, and other conditions of existence.

ENDANGERED SPECIES: Plant or animal species that are in danger of extinction throughout all or a significant part of their range. See THREATENED SPECIES.

ENVIRONMENTAL ASSESSMENT (EA): A systematic environmental analysis of site-specific activities used to determine whether such activities would significantly affect the human environment and whether an environmental impact statement is required.

ENVIRONMENTAL IMPACT STATEMENT (EIS): An analytical document developed for use by decisionmakers to weigh the environmental consequences of a potential action.

EPHEMERAL STREAM: A stream that flows only in direct response to precipitation and whose channel is at all times above the water table.

ESTER: A substance formed by the reaction between an acid and an alcohol, usually with the elimination of water.

EXCHANGE: A transaction in which the Federal Government receives land or interests in lands in exchange for other land or interests in land.

EXOTIC PLANTS: Plants that are not native to the region in which they occur.

FATE (HERBICIDE): What happens to a herbicide after it is applied, including leaching, photodecomposition, and microbial degradation.

FETOTOXIC: Toxic to a fetus.

FOOD CHAIN: A series of plant or animals species in a community, each of which is related to the next as a source of food.

FORAGE: All browse and herbaceous foods available to grazing animals. Forage may be grazed or harvested for feeding.

FORB: A low-growing herbaceous plant that is not a grass, sedge, or rush.

FOREST LAND: Land that is now, or is capable of becoming, at least 10 percent stocked with forest trees and that has not been developed for nontimber use.

FUEL HAZARD REDUCTION: The prescribed burning of chaparral and other brushland communities for the purpose of reducing the potential for catastrophic wildfire.

GELLED GASOLINE: A slash-burning fuel mixture containing an aluminum soap of fatty acid (alumagel) and gasoline. This gelling additive is mixed with gasoline at the rate of 7 pounds per 35 gallons.

GROSS TIMBER VOLUME: The total volume present in a stand without deduction for defects or anticipated logging damage.

GROSS YARDING: Removal from a logging unit of most large tree materials (generally all logs greater than 8 inches in diameter and at least 8 feet in length).

GROUND COVER: Grasses or other plants that keep soil from being blown away or washed away.

HABITAT: The environment in which an organism occurs.

HALF-LIFE: The time required for half the amount of a herbicide introduced into a living system to be eliminated or disintegrated by natural processes.

HECTARE: 10,000 square meters or about 2.47 acres.

HELITORCH: Equipment slung below a helicopter which drops burning gel to ignite prescribed burns.

HERBACEOUS: Having little or no woody tissue and usually persisting for a single season.

HERBICIDE: A substance used to inhibit or destroy plant growth. If its effectiveness is restricted to a specific plant or type of plant, it is called a selective herbicide. If it is effective for a broad range of plants, it is called nonselective.

HERBIVORE: An animal that exclusively eats plants.

HISTOPATHOLOGIC: Pertaining to tissue changes characteristic of diseases.

INFILTRATION: The downward entry of water into the soil.

INSULT: Injury to the body or one of its parts or something that causes or has a potential for causing such injury.

INTEGRATED PEST MANAGEMENT: Use of several techniques (for example, burning, grazing and mechanical, manual, or chemical methods) as one system to control animals or plants where they are unwanted (see BLM Manual 9220).

INTERMITTENT STREAM: A stream that flows only at certain times of the year when it receives water from springs or from some surface source such as melting snow.

IN VITRO: Outside the living body and in an artificial environment.

LABEL: All written, printed, or graphic matter on or attached to pesticide containers as required by law.

LC_{50}: A lethal pesticide concentration rate at which 50 percent of test animals will be killed. It is usually used in testing of fish or other aquatic animals.

LD_{50}: The dosage of toxicant (expressed in milligrams of toxicant per kilogram of animal body weight) required to kill 50 percent of the animals in a test population when given orally.

LEACHING: The movement of chemicals through soil by water or the movement of herbicides out of leaves, stems, or roots into the air or soil.

LIVESTOCK PERFORMANCE: The gaining of weight by livestock.

LOW SITE FOREST LAND: Forest land that is not now or is not capable of producing at least 20 cubic feet per acre per year of commercial coniferous tree species.

MERCHANTABLE VOLUME: That portion of the gross timber volume (less deduction for defects and anticipated logging damage) which is suitable for marketing. Given the same gross timber volume, a stand consisting of many small trees will contain less merchantable volume than a stand consisting of fewer large trees.

METABOLISM: The chemical processes in living cells by which new material is assimilated and energy is provided for vital processes.

METABOLITE: Any substance taking part in or produced by metabolism.

MICROBIAL DEGRADATION: The breakdown by bacteria of chemical substances into simpler components.

MICROCLIMATE: Climatic conditions characteristic of a small area. Microclimates are influenced by local geography and vegetation and may differ from regional climate in temperature, wind, length of growing season, and precipitation.

MICROGRAM (ug): One millionth of a gram.

MOBILITY (HERBICIDE): The capability of a herbicide to be moved easily, vertically or laterally, with the normal movement of water.

MULTIPLE USE: The harmonious use of land for more than one purpose, not necessarily the combination of uses that will yield the highest economic return.

MUTAGEN: A substance that tends to increase the frequency or extent of genetic mutations (changes in hereditary material).

MYONEURAL: Of or relating to both muscle and nerve.

MYOTONIA: Tonic spasm of one or more muscles or a condition characterized by such spasms.

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS): The allowable concentrations of air pollutants in the air specified by the Federal Government in Title 40, Code of Federal Regulations, Part 50. The air quality standards are divided into primary standards (based on the air quality criteria and allowing an adequate margin of safety requisite to protect public health) and secondary standards (based on the air quality criteria and allowing an adequate margin of safety requisite to protect the public welfare from any unknown or expected adverse effects of air pollutants). Welfare includes effects on soils, water, crops, vegetation, manufactured materials, animals, wildlife, weather, visibility, and climate; damage to and deterioration of property; hazards to transportation; and effects on economic values and on personal comfort and well being.

NATIONAL REGISTER OF HISTORIC PLACES: The official list, established by the Historic Preservation Act of 1966, of the nation's cultural resources worthy of preservation. The Register lists archaeological, historic, and architectural properties (districts, sites, buildings, structures, and objects) nominated for their local, state, or national significance by state and Federal agencies and approved by the National Register Staff. The Register is maintained by the National Park Service.

NATIONAL TRAILS SYSTEM. A network of nationally significant trails consisting of (1) scenic, extended trails that provide outdoor recreation opportunities and conserve nationally significant scenic, historic, natural, or cultural qualities of areas through which they pass, and (2) recreation trails that provide a variety of outdoor recreation uses in or reasonably near urban areas.

NATIONAL WILD AND SCENIC RIVERS SYSTEM: A system of nationally designated rivers and their immediate environments that have outstanding scenic, recreational, geologic, fish and wildlife, historic, cultural, and other similar values and are preserved in a free-flowing condition. This system consists of three types (1) Recreation--rivers or sections of rivers readily accessible by road or railroad that may have some development along their shorelines and that may have undergone some impoundment or diversion in the past; (2) Scenic--rivers or sections of rivers free of impoundments, with shorelines or watersheds still largely undeveloped but accessible in places by roads; and (3) Wild--rivers or sections of rivers free of impoundments and generally inaccessible except by trails, with watersheds or shorelines essentially primitive and waters unpolluted.

NEUROPATHY: An abnormal and usually degenerative state of the nervous system or nerves.

NONSELECTIVE HERBICIDE: A herbicide that is generally toxic to all plants. Some selective herbicides may become nonselective if used at very high rates.

NONTARGET VEGETATION: Vegetation that is neither expected nor planned to be affected by herbicide treatment.

NO OBSERVED EFFECT LEVEL (NOEL): (1) the lowest dose of a substance by any route other than inhalation that has been found by experiment with animals to have no toxic effect on the animals or (2) the lowest concentration of a substance in air that has been found by experiment with animals to have no toxic effect on the animals exposed for a defined time.

NOXIOUS WEED: According to the Federal Noxious Weed Act (PL 93-629), a weed that causes disease or has other adverse effects on man or his environment and therefore is detrimental to the agriculture and commerce of the United States and to the public health.

OIL CARRIERS: Nonpolarized medium (e.g., oil, diesel) in which herbicide are sometimes administered to improve spray coverage and penetration.

ORGANOGENESIS: The formation of organs in animals.

OUTSTANDING NATURAL AREA: A natural area established to preserve scenic values and areas of natural wonder.

PALEONTOLOGY: A science dealing with life of past geological periods as known from fossils.

PARTICULATES: Finely divided solid or liquid particles in the air or in an emission, including dust, smoke fumes, mist, spray, and fog.

PATHOGEN: A specific causative agent of disease, such as a bacterium or virus.

PERENNIAL GRASS RELEASE: Any action taken on rangeland to suppress brush overstory and promote growth of perennial grass species. Treatments may include mechanical removal of undesirable brush, herbicide usage or prescribed burning.

PERENNIAL PLANT: A plant that completes its life cycle in more than 2 years.

PERENNIAL STREAM: A stream that flows continuously year round.

PERSISTENCE: The resistance of a herbicide to metabolism and environmental degradation and thus a herbicide's retention of its ability to kill plants for prolonged periods.

PESTICIDE: Any substance or mixture of substances intended for controlling insects, rodents, fungi, weeds, or other plants and animals that are considered pests.

PETIOLE: A slender stem that supports the blade of a foliage leaf.

pH: A numeric value that gives the relative acidity or alkalinity of a substance on a 0 to 14 scale with the neutral point at 7.0. Values lower than 7.0 show the presence of acids, and values greater than 7.0 show the presence of alkalis.

PHOTODECOMPOSITION (PHOTODEGRADATION): The breakdown of a substance, especially a chemical compound, into simpler components by the action of sunlight.

PHOTOSYNTHESIS: Formation of carbohydrates in the tissues of plants exposed to light.

PHYTOTOXIC: Poisonous to plants.

PLANTATION MAINTENANCE: For purposes of this EIS, any vegetation management action taken after planting to promote the survival and establishment of trees. Treatments may include use of biological, mechanical, or manual weeding, mulching, herbicides or a combination of methods.

PRECOMMERCIAL THINNING: Cuttings made in immature stands (10-25 years) in order to stimulate the growth of trees by increasing available soil moisture and nutrients. Such cuttings decrease the time needed to reach merchantable size and increase total merchantable yields from the stand.

PRESCRIBED BURNING: The scientific, intentional burning of wildland fuels in either their natural or modified states under conditions to allow the fire to continue to a predetermined area and to produce the intensity of heat and rate of spread needed to meet certain objectives.

PUBLIC DOMAIN LANDS: Original holdings of the United States never granted or conveyed to other jurisdictions.

PUBLIC LANDS: Any land and interest in land owned by the United States and administered by the Secretary of the Interior through the Bureau of Land Management. May include public domain or acquired lands in any combination.

RADIOLABELLING: A method of creating a radioactive isotope by bombarding a particle with beta or gamma rays. This method is used to trace the movement of particles in fluids.

RANGELAND: In our context, this is land which is nonforest in nature including desert woodlands, scrub (sagebrush, shadscale, creosote, alkali sink and northern coastal), chaparral, woodland-savanna and grasslands.

RANGELAND MANAGEMENT: Management of nonforest lands for a host of values including domestic livestock, wildlife, recreation, cultural resources, sensitive species (plants and animals), and fire prevention and suppression.

RAPTORS: Birds of prey, such as owls, hawks, or eagles.

REFORESTATION: Reestablishment of a tree crop on forest land.

REGENERATION: The renewal of a commercial tree crop, whether by natural or artificial means; also, the young crop itself.

RESEARCH NATURAL AREA: A physical or biological unit in which current natural conditions are maintained insofar as possible. In such areas, activities such as grazing and vegetation manipulation are prohibited unless they replace natural processes and contribute to the protection and preservation of an area. Such recreation activities as camping and gathering plants are discouraged.

RHIZOME: An underground root-like stem, that produces roots and leafy shoots and provides a means for some plants to reproduce.

RIPARIAN: Pertaining to or located along a streambank or other water bodies, such as ponds, lakes, reservoirs, or marshes.

RISK: The probability that a substance will produce harm under specified conditions.

ROSETTE: A cluster of leaves in crowded circles or spirals arising basally from a crown or apically from an axis with greatly shortened internodes.

RUNOFF: The part of the precipitation in a drainage area that is discharged from the area in stream channels, including surface runoff, ground water runoff, and seepage.

SCALPING: The removal of live vegetation, roots and/or slash to expose an area of mineral soil suitable for planting. This work is usually performed using a hand-held hoe or shovel-like tool.

SCARIFICATION: The dislodging of root systems of brush and/or hardwood species and removing surface vegetation. This work is usually accomplished using a tractor with a special blade. Scarification often includes piling or windrowing of slash, brush and unmerchantable trees.

SCOPING: The process by which significant issues relating to a proposal are identified for environmental analysis. Scoping includes eliciting public comment on the proposal, evaluating concerns, and developing alternatives for consideration.

SCRIBNER: A log rule commonly accepted in the EIS area used to determine the board foot volume contained in a log.

SEDIMENTATION: The process or action of depositing sediment.

SELECTIVE HERBICIDE: A herbicide that is toxic to only certain plants. Selectivity may be related to the amount of herbicide used.

SENSITIVE SPECIES (PLANTS): Plant species known or suspected to occur on public lands and that meet one of the following criteria are to be treated as sensitive: 1) Plants identified as candidates for listing as threatened or endangered by the Fish and Wildlife Service (FWS) in a Federal Register Notice of Review; 2) plants officially proposed for listing as threatened or endangered by the FWS in a Federal Register Notice; or 3) plants not meeting either of the above criteria but which have been designated as sensitive by the State Director.

SILVICULTURE: The art of producing and tending a forest.

SITE PREPARATION: For purposes of this EIS, any action taken prior to reforestation efforts (natural or artificial) to create an environment which is favorable for survival of suitable trees during the first growing season. This environment can be created by altering ground cover, soil or microsite conditions; using biological, mechanical, or manual clearing; prescribed burning; herbicides or a combination of methods.

SLASH: The branches, bark, tops, cull logs, and broken or uprooted trees left on the ground after logging has been completed.

SNAG: A standing dead tree or partially dead tree from which some or all of the leaves and limbs have fallen. For management purposes, a snag is defined as any dead or partly dead tree at least 10.2 cm. (4 in.) dbh and at least 1.8 m. (6 ft.) tall.

SOIL COMPACTION: The compression of the soil profile from surface pressure, resulting in reduced air space, lower water-holding capacity, and decreased plant root penetrability.

SOIL COLLOID: An extremely small particle of clay or organic matter that exposes a large surface area on which some herbicides are absorbed.

SOIL PRODUCTIVITY: The capacity of a soil in its normal environment to produce a specified plant or sequence of plants under a specified system of management.

SOIL PROFILE: A vertical section of soil that shows all horizons and parent material.

SORPTION: The process of taking up or holding by either absorption or adsorption.

SPOT TREATMENT: Applying pesticide to a selected individual area as opposed to broadcast application.

STATE HISTORIC PRESERVATION OFFICER (SHPO): The official within each state authorized by the state at the request of the Secretary of the Interior to act as liaison for implementing the National Historic Preservation Act of 1966.

STOCKING STANDARDS: A level of conifer seedling density which is to be achieved. In addition to achieving a desired number of trees per acre, these trees must be well-distributed throughout the plantable acreage.

SUSPENDED SEDIMENT: Very fine soil particles that for long periods of time are maintained in suspension in water by turbulent currents or as colloids.

SUSTAINED YIELD: Achieving and maintaining a permanently high level, annual or regular period production of renewable land resources without impairing the productivity of the land and its environmental values.

SUSTAINED YIELD UNIT: An administrative division of the EIS area for which an allowable cut is calculated.

TARGET STOCKING: A specific stocking standard which is the goal of BLM reforestation efforts. This standard is designed to obtain the desired number of well-spaced trees per acre at the age of first commercial thinning. Target levels assure that intermediate cuts will be realized through commercial thinning. Minimum stocking standards represent a lower (but acceptable) number of well-spaced trees per acre, but no intermediate cuts are anticipated. Below minimum stocking represents an unacceptable number of trees per acre.

TERATOGEN: A substance tending to cause development malformations in unborn human or animal offspring.

TERATOGENESIS: Birth defects.

THREATENED SPECIES: Plant or animal species that are not in danger of extinction but are likely to become so within the foreseeable future throughout all or a significant portion of their range. See ENDANGERED SPECIES.

TIMBERLANDS: See Forest Land.

TIMBER BASE: Acres included in the calculation of the allowable cut.

TIMBER PRODUCTION CAPABILITY CLASSIFICATION (TPCC): A classification system that identifies the commercial forest land base capable of producing timber on a sustained yield basis.

TISSUE BURDEN: The cumulative effects of a substance on a particular tissue.

TOLERANCE: Acceptable level of pesticide residues.

TOPKILL: The death or dieback of the exterior portion of brush or tree crowns.

TOTAL DISSOLVED SOLIDS (TDS): An aggregate of carbonates, bicarbonates, chlorides, sulfates, phosphates, and nitrates of calcium, magnesium, manganese, sodium, potassium, and other cations that form salts. High TDS solutions can change the chemical nature of water, exert varying degrees of osmotic pressures, and often become lethal to life in an aquatic environment.

TRANSLOCATION: The transfer of substances from one location to another in the plant body.

TUMORIGENIC: Causing tumors.

UNDERSTORY VEGETATION: Plants, usually grasses, forbs, and low shrubs, growing beneath the canopy of other plants.

UNGULATES: Hoofed mammals, most of which are herbivores and many of which have horns.

VAPOR PRESSURE: The pressure at which a chemical compound will evaporate.

VASCULAR PLANT: A plant that has a specialized conducting system consisting of xylem and phloem.

VEGETATION REMOVAL: Temporary removal of all vegetation (primarily herbaceous ground cover) along right-of-way (ROW), around well pads, drilling rigs, power plants, etc. to reduce the risk of wildfire.

VIGOR: Relative size and health of individual plants without reference to reproductive success.

VISUAL INTRUSION: A feature (land, vegetation, structure) that is generally considered out of context with the characteristic landscape.

VISUAL RESOURCE MANAGEMENT (VRM): The planning, design, and implementing of management objectives to provide acceptable levels of visual impacts for all resource management activities.

VISUAL RESOURCE MANAGEMENT CLASS (VRM CLASS): The degree of visual change acceptable within the existing characteristic landscape. An area's classification is based upon the physical and sociological characteristics of any given homogeneous area and serves as a management objective. Class I (preservation) provides the highest level of protection for scenic values, and Class IV the lowest level.

VOLATILIZATION: The vaporizing or evaporating of a chemical substance.

WATER TABLE: The upper limit of the part of the soil or underlying rock material that is wholly saturated with water.

WEED: A plant out of place or growing where not desired.

WEED-INFESTED ACRE: Any part of an acre of land that is infested with weeds.

WILDERNESS: An area designated by Congress as part of the National Wilderness Preservation System. Wilderness areas are generally undeveloped Federal lands that retain their primeval character and influence without improvements or human habitation.

WILDERNESS STUDY AREA (WSA): A roadless area that has been found to have wilderness characteristics and that is being subjected to intensive analysis in the BLM planning system and to public review to determine wilderness suitability.

WIPER APPLICATION: Wiping herbicide onto tall growing weeds from an applicator soaked with herbicide, usually by a rope or pad of absorbant material.

YARDING: The act or process of conveying logs to a landing.

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ABBREVIATIONS

ai	active ingredient
BLM	U.S. Department of the Interior, Bureau of Land Management
BPA	U.S. Department of Energy, Bonneville Power Administration
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FS	U.S. Department of Agriculture, Forest Service
ha	hectare
kg	kilogram
m	meter
mg	milligram
MOS	margin of safety
mph	miles per hour
NEPA	National Environmental Policy Act
NCI	National Cancer Institute
NOEL	no observed effect level
NRCC	National Research Council of Canada
ppm	parts per million
ppb	parts per billion
SCS	U.S. Department of Agriculture, Soil Conservation Service
USDA	U.S. Department of Agriculture
USDI	U.S. Department of the Interior
VRM	visual resource management
WSA	wilderness study area

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